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FROM

D. G. Fitzjerrell

TO

J. A. Rummel, Ph.D.

DATE

4/10/73

WORK ORDER REF:

DM-110T

WORK STATEMENT PARA:

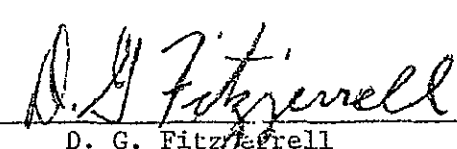
NAS9-12932

REFERENCE:

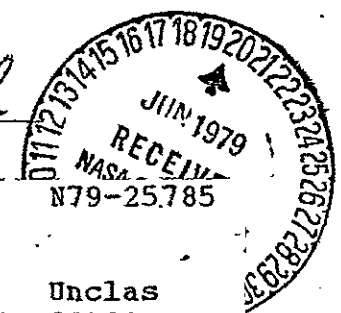
SUBJECT

Program for the Solution of Multipoint  
Boundary Value Problems of Quasilinear Differential Equations

The program is designed to provide numerical solution of multipoint boundary value problems governed by a system of up to 20 first-order ordinary differential equations. This system of equations will be subject to a set of up to 20 boundary conditions. Linear equations are solved by a method of superposition of solutions of a sequence of initial value problems. For nonlinear equations and/or boundary conditions, the solution is iterative and in each iteration a problem like the linear case is solved. A simple Taylor series expansion is used for the linearization of both nonlinear equations and nonlinear boundary conditions. The perturbation method of solution is used in preference to quasilinearization because of programming ease, smaller storage requirements, and experiments indicate that the desired convergence properties exist although no proof of convergence is given. The use of this program for nonlinear differential equations is also applicable to the inverse problem of; given a model and an output, determine the system that gave this output. These are often called "parameter estimation" or "systems identification" problems.

  
D. G. Fitzjerrell

(NASA-CR-160208) PROGRAM FOR THE SOLUTION  
OF MULTIPOINT BOUNDARY VALUE PROBLEMS OF  
QUASILINEAR DIFFERENTIAL EQUATIONS (General  
Electric Co.) 47 p HC A03/MF A01 CSCL 09B

Unclas  
G3/61 21422

CONCURRENCES

Counterpart:

Medical Projects  
Unit Manager: CWFulcherEngr & Advanced Programs  
Subsection Mgr. WJBeittel

DISTRIBUTION GE/AGS: Central Product File  
R. C. Croston, Ph.D.  
R. F. Hassell  
B. G. Hall  
V. J. Marks

NASA/JSC: Technical Library/JM6  
(1979 Distribution)

Page No.

1 of 1

## PROGRAM DESCRIPTION GUIDE

### A. IDENTIFICATION

Program Name - MINIQASI

Programmer's Name - V. J. Marks and B. G. Hall

Date of Issue - 4/9/73

### B. GENERAL DESCRIPTION

The program is designed to provide numerical solution of multipoint boundary value problems governed by a system of up to 20 first-order ordinary differential equations. This system of equations will be subject to a set of up to 20 boundary conditions. Linear equations are solved by a method of superposition of solutions of a sequence of initial value problems. For nonlinear equations and/or boundary conditions, the solution is iterative and in each iteration a problem like the linear case is solved. A simple Taylor series expansion is used for the linearization of both nonlinear equations and nonlinear boundary conditions. The perturbation method of solution is used in preference to quasilinearization because of programming ease, smaller storage requirements, and experiments indicate that the desired convergence properties exist although no proof of convergence is given. The use of this program for nonlinear differential equations is also applicable to the inverse problem of; given a model and an output, determine the system that gave this output. These are often called "parameter estimation" or "systems identification" problems.

### C. USAGE AND RESTRICTIONS

Machine and Compiler Required - Xerox Sigma 3  
- ANSI FORTRAN

Peripheral Equipment Required - Card Reader and Line Printer

Approximate Amount of Memory Required - 13B3 hexadecimal (5043 decimal)

### D. PARTICULAR DESCRIPTION

Equations Used and Derivations - See Reference 1

Definition of Terms Used - See Reference 1, Appendix A and B

Detailed Description - The program is designed such that a broad class of problems can be solved with a minimum amount of programming effort by the user. The only programming required by the

user is that which is involved with the description of the governing equations for a specific problem, and this task is completed within the framework of a subroutine furnished with the program package. All other pertinent information is communicated to the program by means of input data cards.

After setting up COMMON and DATA blocks, the main program begins execution by reading data to obtain values for certain key control parameters, boundary condition information, and estimates of initial values of the solution. This data is then reduced as follows: the boundary conditions are arranged in order of their occurrence with respect to the independent variable; the limits on the independent variable are changed if need be to span the boundary conditions; any initial conditions which were input as boundary conditions are placed in the initial value vector where they supersede any previous values. For each exact initial condition, the order of the system to be solved is reduced by one until the required number of solutions to be used in the superposition scheme has been determined. The perturbation factors are then checked to ensure that none of the perturbations are null, and the required matrix dimensions are calculated. Finally, an echo check of initial conditions, input data, and key program parameters is accomplished by outputting appropriate values.

#### Iterations

Next, up to a certain number of iterations are taken in an attempt to solve the problem as input. The initial values of the best estimate of the solution at each iteration are used to generate both the "previous approximation" and the particular solutions to be used in forming the next approximation. These solutions are started from initial values which are perturbed from those of the previous approximation in the manner already discussed. The integration of these initial value problems is undertaken by a fourth order Runge Kutta scheme especially adapted for the data structuring employed in QUASI. Integration starts at the minimum value of the independent variable and stops at the last prescribed boundary condition during intermediate iterations and at the maximum value during the final iteration. Output of integration results is controlled by the user through an input parameter.

The superposition of these solutions is implied by interrupting the integration whenever a boundary condition is encountered and setting one of the algebraic equations into a storage area for future use in determining the superposition constants. When all boundary conditions have been so set, a linear algebraic system is solved to obtain the solution as desired (exact fit or best fit in least squares sense). Following the determination of the constants, the best estimate of the initial values is updated according to the desired method and if convergence has not occurred, within the limiting number of iterations, a new iteration is begun. Convergence occurs whenever all of the constants of the perturbed solutions are smaller in absolute value than a preassigned value.

## E. DESCRIPTION OF INPUT (Extracted from Ref.1)

In order to utilize the program the user must successfully communicate a variety of descriptive and control information. There are two basic chores involved. The first consists of programming the system of equations into the structure of one of the FORTRAN subroutines. The second task involves the input of program control parameters, boundary value information; and other data necessary or desirable to a successful program execution.

### Nonlinear System

### Programming of Equations

The way in which the nonlinear system may be described in the RHS subroutine is as follows:

Denoting the previous approximation to the solution of the nonlinear system

$$\dot{y} = g(y, t)$$

as  $y_0$ , the linearized system can be written

$$\dot{y} = g(y_0, t) + \frac{\partial g(y_0, t)}{\partial y} (y - y_0)$$

where  $\frac{\partial g(y_0, t)}{\partial y}$  denotes the Jacobian of the nonlinear system evaluated using the approximation  $y_0$ . Evaluating the indicated differences in current and previous approximations leads to a system of equations

$$\dot{y}_i = g_i(y_0, t) + \sum_{j=1}^N \frac{\partial g_i(y_0, t)}{\partial y_j} [y_j(t) - y_{0j}(t)]$$

These equations can be programmed as above using the vector  $Y$  for the current solution and the vector  $Y_0$  (or  $Y\phi$ ) for the previous approximation. Of course, the values of  $g_i$  and  $\partial g_i / \partial y_i$  are to be computed using the previous approximation.

### Linear System

The actual linear equations are placed in the RHS subroutine. No further statements are required.

#### 1. Data Input

The input data is read by the program in four groups: integer control parameters, real control parameters, boundary value information, and initial conditions and related data. The input for each section is terminated by a blank record and the procedure is so structured to allow an arbitrary ordering of records in the input list and an arbitrary amount of data to be read in any one of the four groups. This input procedure is particularly convenient for multiple data sets for the same system of equations, because only that information to be changed need be included in the input list.

The integer and real control parameters have been included in two COMMON blocks, and input of values for these parameters is done by reference to the order of occurrence of a particular element in a COMMON block. This practice greatly simplifies input commands.

### Integer Control Parameters

The elements of the integer COMMON block have been EQUIVALENCED to elements of a vector of integer variables occupying the same storage location and can be referenced by name or by lineal subscript location within the vector. These elements are input by entering the vector subscript corresponding to the element location and the desired value of that element in the first two fields of a record. Listed below are the most commonly used input integer variables with the vector subscript as the key variable. The variables are all given a default value. If the value is not listed, it is zero. In most cases, the zero value is an ideal value. The format for integer input is

FORMAT (215)

<u>ELEMENT NUMBER</u>	<u>DESCRIPTION</u>
1	<p>output control parameter. Zero default.</p> <p>= 0 gives minimal output. This includes the initial conditions of each iteration and the superposition constants. On the final iteration the unperturbed or nonlinear solution is output.</p> <p>= 1 adds to the above output the initial condition change that would be taken if the change is unconstrained, the cartesian length or norm of this vector and the dot product of successive unit vectors parallel to the changes. The matrix in which the boundary conditions and results of the boundary condition operators on the perturbed solutions is also output.</p> <p>= 2 adds to all the above output, the pivotal elements used in solving for the superposition.</p> <p>= 3 adds the unperturbed or nonlinear solution to the above output.</p> <p>= 4 adds the perturbed solutions to the above output.</p>
2	<p>= 0 for nonlinear problem. Zero default.</p> <p>= 1 for linear problem.</p>
3	See Appendix D for explanation. Zero default.
4	<p>= maximum number of recurrence iterations.</p> <p>Default value = 5.</p>

<u>ELEMENT NUMBER</u>	<u>DESCRIPTION</u>
5	= 0 keeps a constant maximum value for the norm of the change of the initial condition vector. Zero default.  0 allows the maximum value for the norm of the change of the initial condition vector to be reduced to the smallest norm encountered.
6	= total number of boundary conditions to be imposed on the system. Must be input except on initial value problems.
7	= number of dependent variables in the problem which have non-null derivative expressions. Must be input because default is meaningless.
8	= number of dependent variables which do have null derivative expressions; i.e., constants to be identified. These are the last elements of the state variable vector. Zero default.
9	output control parameter which gives frequency at which output of information about the solution is to occur. It refers to the nominal number of integration steps between regular output points. It should be noted that output will also occur at points where boundary conditions have been specified. Default value = 5.
10	≠ 0 causes the original initial conditions to be saved for use with subsequent data sets.  = 0 the subsequent data sets will use the last information then available for initial conditions. Zero default.
11	used to signal computation and output of the Wronskian of the solution. Zero default.  ≤ 0 no computation  = 1 computation only at end of integration on final solution.  > 1 computation each time a boundary value is encountered during solution.

The remaining elements in the integer COMMON block are established during execution and need not be input. A blank record should follow at this point to terminate integer input.

### Real Control Parameters

The parameters in the real COMMON block are input in the same manner as those in the integer COMMON block (except, of course, for different field specifications). The vector subscript is again the key variable and is listed below with the corresponding parameter description. The format for real parameter input is

FORMAT (15,G15.7)

<u>ELEMENT NUMBER</u>	<u>DESCRIPTION</u>
1	the nominal integration step size to be used--default value = 0.1.
2	a standard perturbation factor to be applied to all unknown initial value estimates unless otherwise specified--default value = 1.2.
3	the maximum value of the "length" of the change in the initial value vector--if input as zero, will override 5th element of integer COMMON block being non-zero and allow unrestricted changes. Zero default.
4	the initial value of the range of the independent variable. It is set to the smaller of (zero or the input value) or the smallest time of a boundary condition.
5	the final value of the range of the independent variable. It is set to the larger of (zero or the input value) or the largest time of a boundary condition. Must be input for initial value problems.
6	a scale factor for the determinant of the coefficient matrix used in calculating the superposition constants. Default value is unity.
7,8	small parameters which need not be input.
9,10	parameters which should not be input.
11	a small parameter used to check on ill conditioning while solving for superposition constants. Default 1.E-20.
12	convergence test parameter. Default 1.E-8.
13	parameter used in checking for nearly null initial values. Default 1.E-3.

### Boundary Value Information

For each boundary condition imposed, a record consisting of five fields is read. The first two fields are integer values, the next two fields are real values, and the last field is another integer value. The format used is

FORMAT (2I5,2G15.7,I5)

<u>FIELD</u>	<u>DEFINITION</u>
1	an identifying integer for the boundary condition--these values should range from one through the number of boundary conditions used, with no repetition--they will later be arranged in order according to the ascending values of the independent variable at which the boundary condition occurs.
2	the element of the state variable vector on which the condition is imposed. See Appendix D for <u>general</u> linear and nonlinear boundary conditions.
3	the value of the independent variable at which the condition is imposed.
4	the numerical value of the boundary value.
5	a flag indicating whether the boundary condition is to be met in an exact sense or a best-fit sense-- = 0 implies exact. > 0 implies least-square.

After including one such record for each boundary condition in this group of data, a blank record should again be used to terminate input.

#### Initial Conditions and Related Data

QUASI requires that initial conditions, either exact or estimated, for each element of the state variable vector be available at the beginning of a solution. It is often the case that some boundary conditions are specified at an initial value of the independent variable, in which case they automatically are placed in the initial condition vector. For each element of the state variable vector for which this does not occur, an estimate of the initial condition should be input at this time. See input of integer parameters, 10th element and SKIP, Appendix B of Reference 1. Each initial condition to be input is included on one record consisting of two integer fields followed by four real fields read according to:

FORMAT (15,G15.7, 3G10.3)

<u>FIELD</u>	<u>DEFINITION</u>
1	integer indicating the element of the state variable vector.
2	= 0 implies an unknown initial condition without bounds (see fields 5, 6) - 1 implies an unknown initial condition with bounds. - 1 implies an exact initial condition. If this is the case, the fields, 4, 5, and 6 are ignored.

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<u>FIELD</u>	<u>DEFINITION</u> (cont'd)
3	the floating-point value of the initial condition. Default value = 1.0.
4	the value of an associated perturbation factor, if different from standard value or zero.
5,6	if one of these parameters is non-zero, the larger of the two values will be used as an upper bound for the initial condition and the other value will be a lower bound and if the second field is null, it is then changed to +1.

A blank record is once again used to terminate input of this group of data. This concludes input of a complete data set. If subsequent data sets are incomplete, i.e., with one or more of the four data groups empty, simply include a blank record as a terminator for the empty set and continue as before.

## 2. Control and Program Cards - (begin Col. 1)

```
!JOB QUASI
!FORTRAN
```

(Source Cards - See Appendix A)

```
!EOD
!LOAD
!$ROOT 256,,G0
!$MP
!END
!XEQ
```

(Input Data)

```
!EOD
```

## F. DESCRIPTION OF OUTPUT

Printer Output - The iteration number and solution are given for each boundary value. See Appendix A for sample output.

## G. INTERNAL CHECKS AND EXITS

Program exits when input conditions for convergence are met.

## H. INDEPENDENT SUBROUTINES

None

I. SYSTEM SUBROUTINES

No special subroutines.

J. COMPLETION OR FINAL CHECKOUT DATE - 4/9/73

Source listing and sample cases are given in Appendix A. The first sample problem is a duplication of the first sample problem discussed in Reference 1. In this problem the boundary conditions are nonlinear and are fitted in a least square sense. The programming of the non-linear boundary condition equation is done in subroutine NLBC. The second example problem solves the same system of equations appearing in subroutine RHS, but linear boundary conditions are used and the subroutine NLBC is ignored. In the second example problem, the linear boundary conditions are also fitted in the least square sense.

REFERENCES

1. QUASI - Solution of Multipoint Boundary Value Problems of Quasilinear Differential Equations - Bart Childs, et al. University of Houston RE7-69, September 1969.

APPENDIX A  
SOURCE LISTING  
AND  
SAMPLE CASES

```

1 C*****
2 C***** QUASI *****
3 C*****
4 C*****
5 C
6     INTEGER QBV,XACTIC,SKIP,IBIG(135),XACTBV
7     REAL      RBIG(204),LOWER,SVEC( 462),LF,IC,IIC,C( 462),Y(20,21)
8     COMMON    IIC(20),IC(20),YVEC( 420),YNL( 80),LF(20),S(21,22),
9     1         DELT,      SPTRB,      PNORM,      TSTART,      TSTOP,
10    1         DET,       SMALL,       ZERO,       DETT,       TRACE,
11    2         DZERO,     CONV,        DPTRB,      DTEMP,      DN1,
12    3H,RN1,RN2,T,
13    4TAVG,TL,TN,TBMT,TEM,TEMP,TTEM,TBV( 21),BV( 20),
14    5 UPPER(20),LOWER(20),PTRB(20),AUX(10),CQB(20),
15    5 DIC(20),YPTRB(20),DELTP,DELTM,TNORM,SNORM,ANORM,TBVK,DGT,
16    1         IOUT,      LIN,        IQBVS,      LITER,      NORMRD,
17    1         NBV,       NEQ,        NCN,        NWRITE,     SKIP,
18    1         ITRACE,    LIMIT,      IVARY,      IAF(2),
19    1NVECT,IXTRA,
20    1JXTRA,KXTRA,NOUT,NL,NSPACE,NRCD,
21    2NRSD,NRYD,I,II,ICOUNT,IN1,IN2,INTKEY,IPUNT,IQ,IS,ISUB,ITEMP,ITER,
22    3 J,JJ,JQ,JSUB,K,KK,KOUNT,KOUT,KQ,KTEM,MITER,NBVM,NCOL,NRANKC,
23    4 NRBS,QBV(20),XACTBV(21),XACTIC(20),IQBV(20),NR,IG0,NE,NI
24    EQUIVALENCE (YVEC,Y),(S,SVEC),(YVEC,C),(IOUT,IBIG),(DELT,RBIG)
25 C****WARNING, CHECK COMPILER FOR THIS OPTION****
26 C****INPUT INTEGER PARAMETERS****
27 C****WARNING, CHECK COMPILER FOR THIS OPTION****
28     WRITE (102,15)
29     WRITE (6,15)
30     15 FORMAT ('/ MINI=QUASI MODEL'/
31     * ' REFER TO GE-AGS USER GUIDE TIR 741-MED=30XX'//)
32     CALL INIT
33 1000 CONTINUE
34     CALL READIT
35     CALL SORTBV
36     CALL NTLIZE
37     CALL ECHOIN
38     5 CONTINUE
39     CALL ESTABL
40     CALL NGRATE
41     IVARY=4
42     7 CONTINUE
43     LIMIT=4
44     CALL ONETEN
45     GO TO (17,18,19),IVARY
46 17 CONTINUE
47     CALL WRITES
48 20 GO TO (7,18),IG0
49 18 CONTINUE
50     CALL STORES
51     IF (K-NBV)7,7,19
52 19 CONTINUE
53     IF (ITER-MITER)25,1000,1000
54 25 CONTINUE
55     LIMIT=1
56 11 CONTINUE
57     CALL WRITES
58     GO TO (12,5,1000),LIMIT

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59      12 CONTINUE
60      DETT = DET
61      CALL GJRWLS
62      LIMIT = 2
63      IF (IPUNT=2)13,11,13
64      13 CONTINUE
65      CALL NEWIC
66      IF (J) 14,11,11
67      14 CONTINUE
68      CALL MODIFY
69      GO TO 13
70      END


---


71      SUBROUTINE INIT
72      C
73      INTEGER QBV,XACTIC,SKIP,IBIG(135),XACTBV
74      REAL      RBIG(204),LOWER,SVEC( 462),LF,IC,IIC,C( 462),Y(20,21)
75      COMMON    IIC(20),IC(20),YVEC( 420),YNL( 80),LF(20),S(21,22),
76      1          DELT,      SPTRB,      PNORM,      TSTART,      TSTOP,
77      1          DET,      SMALL,      ZERO,      DETT,      TRACE,
78      2          DZERO,      CONV,      OPTRB,      DTEMP,      DN1,
79      3H,RN1,RN2,T,
80      4TAVG,TL,TN,TBMT,TEM,TEMP,TTEM,TBV( 21),BV( 20),
81      5 UPPER(20),LOWER(20),PTRB(20),AUX(10),CQBV(20),
82      5 DIC(20),YPTRB(20),DELT,DELT,TNORM,SNORM,ANORM,TBVK,DOT,
83      1          IOUT,      LIN,      IQBVS,      LITER,      NORMRD,
84      1          NBV,      NEQ,      NCN,      NWRITE,      SKIP,
85      1          ITRACE,      LIMIT,      IVARY,      IAF(2),
86      1NVECT,IXTRA,
87      1JXTRA,KXTRA,NOUT,NL,NSPACE,NRCD,
88      2NRSD,NRYD,I,II,ICOUNT,IN1,IN2,INTKEY,IPUNT,IQ,IS,ISUB,ITEMP,ITER,
89      3 J,JJ,JQ,JSUB,K,KK,KOUNT,KOUT,KQ,KTEM,MITER,NBVM,NCOL,NRANKC,
90      4 NRWS,QBV(20),XACTBV(21),XACTIC(20),IQBV(20),NR,IG0,NE,NI
91      EQUIVALENCE (YVEC,Y),(S,SVEC),(YVEC,C),(IOUT,IBIG),(DELT,RBIG)
92      DATA IDUM,IDUN/' ', 'BV'/
93      DO 10 M = 1,135
94      10 IBIG(M)=0
95      RBIG(1)=1.E=1
96      DO 20 I =2,204
97      20 RBIG(I)=0.
98      DO 30 I = 1,20
99      30 IIC(I)=.1E1
100      NRSD = 21
101      NRCD = 21
102      NRYD = 20
103      LITER=5
104      DET=.1E1
105      SPTRB=.12E1
106      SMALL=.1E=9
107      ZERO=5.E=6
108      DZERO= 1.E=20
109      DPTRB = 1.E=3
110      CONV = 1.E=8
111      NWRITE=5
112      IAF(1)=IDUM
113      IAF(2)=IDUN
114      RETURN
115      END


---


116      SUBROUTINE READIT
117      C

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```

118     INTEGER QBV,XACTIC,SKIP,IBIG(135),XACTRV
119     REAL      RBIG(204),LOWER,SVEC( 462),LF,IC,IIC,C( 462),Y(20,21)
120     COMMON    IIC(20),IC(20),YVEC( 420),YNL( 80),LF(20),S(21,22),
121     1          DELT,      SPTRB,      PNORM,      TSTART,      TSTOP,
122     1          DET,       SMALL,      ZERO,       DETT,       TRACE,
123     2          DZERO,     CONV,       DPTRB,      DTEMP,      DN1,
124     3H,RN1,RN2,T,
125     4TAVG,TL,TN,TBMT,TEM,TEMP,TTEM,TBV( 21),BV( 20),
126     5 UPPER(20),LOWER(20),PTRB(20),AUX(10),CQB(20),
127     5 DIC(20),YPTRB(20),DELIP,DELTN,TNORM,SNORM,ANORM,TBVK,DOT,
128     1          IOUT,      LIN,       IQBVS,      LITER,      NORMRD,
129     1          NBV,       NEQ,       NCN,       NWRITE,      SKIP,
130     1          ITRACE,    LIMIT,     IVARY,      IAF(2),
131     1NVECT,IXTRA,
132     1JXTRA,KXTRA,NOUT,NL,NSPACE,NRCD,
133     2NRSD,NRYD,1,II,ICOUNT,JN1,IN2,INTKEY,IPUNT,IQ,IS,ISUB,ITEMP,ITER,
134     3 J,JJ,JQ,JSUB,K,KK,KCOUNT,KOUT,KQ,KTEM,MITER,NBVM,NCOL,NRANKC,
135     4 NRROWS,QBV(20),XACTBV(21),XACTIC(20),IQBV(20),NR,IG0,NE,NI
136     EQUIVALENCE (YVEC,Y),(S,SVEC),(YVEC,C),(IOUT,IBIG),(DELT,RBIG)
137     WRITE (6,312)
138     1 READ(5,300) IN1,IN2
139     IF(IN1)230,5,7
140     5 WRITE(6,302)
141     GO TO 11
142     7 WRITE(6,301) IN1,IN2
143     IBIG(IN1)=IN2
144     GO TO 1
145 C****INPUT REAL PARAMETERS****
146     11 READ(5,305) IN1,RN1
147     IF(IN1)15,15,17
148     15 WRITE(6,302)
149     GO TO 20
150     17 WRITE(6,306) IN1,RN1
151     IM100=IN1-100
152     IF(IM100)18,18,19
153     18 RBIG(IN1)=RN1
154     GO TO 11
155     19 AUX(IM100)=RN1
156     GO TO 11
157 C****INPUT BOUNDARY VALUE INFORMATION****
158     20 IQBVM = IQBVS
159     21 READ(5,300) I,IN1,RN1,RN2,IN2
160     IF(I)901,901,905
161     901 WRITE(6,302)
162     GO TO 31
163     905 WRITE(6,301) I,IN1,RN1,RN2,IN2
164     IF(IN1)906,907,907
165     906 IF(IN1+100)907,907,908
166     907 QBV(I)=IN1
167     908 TBV(I)=RN1
168     BV(I)=RN2
169     XACTBV(I)=IN2
170     IF(IN1)909,21,21
171     909 IF(IN1+100)910,910,22
172     910 IF(QBV(I))911,22,22
173     911 IN2=QBV(I)/100
174     IF(IN1-(QBV(I)-IN2*100))22,912,912
175     912 IQBVS=-IN2
176     22 IF(IN1+100) 851,851,850

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177      850 QBV(I) = -((IQBVS+1)*100-IN1)
178      851 IN1 = -QBV(I)+(QBV(I)/100)*100
179          IF(IN1)913,21,913
180      913 DO 23 I=1,IN1
181          IQBVS = IQBVS + 1
182          READ (5,305) IQBV(IQBVS),CQBV(IQBVS)
183          IF(IQBVS(IQBVS))23,914,23
184      914 IQBV(IQBVS)=1
185          23 WRITE (6,306) IQBV(IQBVS),CQBV(IQBVS)
186          IF(IQBVS-IQBVM)24,21,25
187          24 IQBVS=IQBVM
188              GO TO 21
189          25 IQBVM=IQBVS
190              GO TO 21
191  C****INPUT INITIAL CONDITIONS AND RELATED DATA****
192      31 READ (5,310) IN1,IN2,DN1,RN1,RN2,RN3
193          IF(IN1)32,32,915
194      32 WRITE(6,302)
195          GO TO 34
196      915 WRITE(6,311)IN1,IN2,DN1,RN1,RN2,RN3
197              IIC(IN1) = DN1
198              PTRB (IN1) = RN1
199              XACTIC (IN1) = IN2
200          IF(ABS(RN2)-DZER0)916,916,917
201      916 IF(ABS(RN3)-DZER0)31,917,917
202      917 IF(RN2-RN3)918,918,33
203      918 TEMP=RN2
204              RN3 = TEMP
205      33          UPPER(IN1) = RN2
206              LOWER(IN1) = RN3
207              XACTIC (IN1) = 1
208          GO TO 31
209      34 RETURN
210      230 STOP
211      300 FORMAT (2I5,2E15.7,I5)
212      301 FORMAT (16H INPUT DATA CARD,2I5,2E15.7,I5)
213      302 FORMAT (15X,16H BLANK DATA CARD,/)
214      305 FORMAT (I5,E15.7)
215      306 FORMAT (16H INPUT DATA CARD, I5, E15.7)
216      310 FORMAT (2I5,E15.7,3E10.3)
217      311 FORMAT (16H INPUT DATA CARD,2I5,4E15.7)
218      312 FORMAT(1H1)
219  END
220  SUBROUTINE SORTBV
221  C
222  C****SORT BOUNDARY VALUES****
223      INTEGER QBV,XACTIC,SKIP,IBIG(135),XACTBV
224      REAL      RBIG(204),LOWER,SVEC( 462),LF,IC,IIC,C( 462),Y(20,21)
225      COMMON    IIC(20),IC(20),YVEC( 420),YNL( 80),LF(20),S(21,22),
226      1          DELT,      SPTRB,      PNORM,      TSTART,      TSTOP,
227      1          DET,      SMALL,      ZER0,      DETT,      TRACE,
228      2          DZER0,      CONV,      DPTRB,      DTEMP,      DN1,
229      3H,RN1,RN2,T,
230      4TAVG,TL,TN,TBMT,TEM,TEMP,TTEM,TBV( 21),BV( 20),
231      5 UPPER(20),LOWER(20),PTRB(20),AUX(10),CQBV(20),
232      5 DIC(20),YPTRB(20),DELT,DELT, TNORM,SNORM,ANORM,TBVK,DUT,
233      1          IOUT,      LIN,      IQBVS,      LITER,      NORMRD,
234      1          NBV,      NEQ,      NCN,      NWRITE,      SKIP,
235      1          ITRACE,      LIMIT,      IVARY,      IAF(2),

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236      1NVECT,IXTRA,
237      1JXTRA,KXTRA,NOUT,NL,NSPACE,NRCD,
238      2NRSD,NRYD,I,II,ICOUNT,IN1,IN2,INTKEY,IPUNT,IQ,IS,ISUB,ITEMP,ITER,
239      3 J,JJ,JQ,JSUB,K,KK,KOUNT,KOUT,KQ,KTEM,MITER,NBVM,NCOL,NRANKC,
240      4 NR0WS,QBV(20),XACTBV(21),XACTIC(20),IQBV(20),NR,IQ0,NE,NI
241      EQUIVALENCE (YVEC,Y),(S,SVEC),(YVEC,C),(IOUT,IBIG),(DELT,RBIG)
242      34      IF (NBV)42,42,919
243      919      IF(NBV=1)41,41,920
244      920      IS=1
245      NBVM=NBV-1
246      35 DO 40 I=IS,NBVM
247      IF(TBV(I+1)=TBV(I))37,40,40
248      37 TEMP=TBV(I)
249      TBV(I)=TBV(I+1)
250      TBV(I+1)=TEMP
251      TEMP=BV(I)
252      BV(I)=BV(I+1)
253      BV(I+1)=TEMP
254      ITEMP=QBQ(1)
255      QBQ(I)=QBQ(I+1)
256      QBQ(I+1)=ITEMP
257      ITEMP=XACTBV(I)
258      XACTBV(I)=XACTBV(I+1)
259      XACTBV(I+1)=ITEMP
260      IF(I-1)35,35,38
261      38 IS= I-1
262      GO TO 35
263      40 CONTINUE
264      41 IF(TSTOP=TBV(NBV))921,921,922
265      921 TSTOP=TBV(NBV)
266      922 IF(TSTART=TBV(1))42,42,923
267      923 TSTART=TBV(1)
268      42 CONTINUE
269      RETURN
270      END
271      SUBROUTINE NTLIZE
272      C
273      INTEGER QBV,XACTIC,SKIP,IBIG(135),XACTBV
274      REAL      RBIG(204),L0WER,SVEC( 462),LF,IC,IIC,C( 462),Y(20,21)
275      COMMON      IIC(20),IC(20),YVEC( 420),YNL( 80),LF(20),S(21,22),
276      1          DELT,      SPTRB,      PNORM,      TSTART,      TSTOP,
277      1          DET,      SMALL,      ZERO,      DETT,      TRACE,
278      2          DZERO,      CONV,      DPTRB,      DTEMP,      DN1,
279      3H,RN1,RN2,T,
280      4TAVG,TL,TN,TBMT,TEM,TEMP,TTEM,TBV( 21),BV( 20),
281      5 UPPER(20),L0WER(20),PTRB(20),AUX(10),CQBQ(20),
282      5 DIC(20),YPTRB(20),DELT,DELT,TDORM,SNORM,ANORM,TBVK,D0T,
283      1          IOUT,      LIN,      IQBVS,      LITER,      NORMRD,
284      1          NBV,      NEQ,      NCN,      NWRITE,      SKIP,
285      1          ITRACE,      LIMIT,      IVARY,      IAF(2),
286      1NVECT,IXTRA,
287      1JXTRA,KXTRA,NOUT,NL,NSPACE,NRCD,
288      2NRSD,NRYD,I,II,ICOUNT,IN1,IN2,INTKEY,IPUNT,IQ,IS,ISUB,ITEMP,ITER,
289      3 J,JJ,JQ,JSUB,K,KK,KOUNT,KOUT,KQ,KTEM,MITER,NBVM,NCOL,NRANKC,
290      4 NR0WS,QBV(20),XACTBV(21),XACTIC(20),IQBV(20),NR,IQ0,NE,NI
291      EQUIVALENCE (YVEC,Y),(S,SVEC),(YVEC,C),(IOUT,IBIG),(DELT,RBIG)
292      DELT=1.1 *DELT
293      DELTM=0.9 *DELT
294      C****INITIALIZE IC,DIC, AND XACTIC****

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```

295      NVECT=NEQ+NCN
296      DO 50 I=1,NVECT
297      DIC(I) = 0.
298      IC(I)=IIC(I)
299      IF(NBV)47,47,49
300      47 IF(XACTIC(I))49,48,48
301      48 XACTIC(I)=-1
302      49 IF(XACTIC(I)+1)924,50,50
303      924 XACTIC(I) = XACTIC(I)+4
304      50      CONTINUE
305      TNORM = 1.
306      SNORM = PNORM
307      NR0WS=NBV+1
308      IF (NBV)61,61,52
309      52 DO 60 I=1,NVECT
310      IF(ABS(TBV(I)-TSTART))55,55,61
311      55 IQ=QBV(I)
312      IF(IQ)57,57,56
313      56 IC(IQ)=BV(I)
314      57 IF(XACTBV(I))58,58,60
315      58 IF(IQ)60,60,59
316      59 NR0WS = NR0WS -1
317      XACTBV(I)=-1
318      XACTIC(IQ) = XACTIC(IQ) - 4
319      60 CONTINUE
320      61 K0UNT=0
321      DO 70 I=1,NVECT
322      IF(XACTIC(I))62,63,63
323      62 K0UNT=K0UNT+1
324      GO TO 70
325      63 IF(ABS(PTRB(I))-DZER0)64,70,70
326      64 PTRB(I)=SPTRB
327      70 CONTINUE
328      ITER=0
329      MITER=LITER
330      IF(K0UNT=NVECT)926,925,925
331      925 MITER=1
332      926 NRANKC=NVECT-K0UNT+1
333      NC0L=NRANKC+1
334      RETURN
335      END
336      SUBROUTINE ECH0IN
337      C
338      C      ECH0IN
339      INTEGER QBV,XACTIC,SKIP,IBIG(135),XACTBV
340      REAL      RBIG(204),LOWER,SVEC( 462),LF,IC,IIC,C( 462),Y(20,21)
341      COMMON      IIC(20),IC(20),YVEC( 420),YNL( 80),LF(20),S(21,22),
342      1          DELT,      SPTRB,      PNORM,      TSTART,      TSTOP,
343      1          DET,      SMALL,      ZER0,      DETT,      TRACE,
344      2          DZER0,      CONV,      DPTRB,      DTEMP,      DN1,
345      3H,RN1,RN2,T,
346      4TAVG,TL,TN,TBMT,TEM,TEMP,TTEM,TBV( 21),RV( 20),
347      5 UPPER(20),LOWER(20),PTRB(20),AUX(10),CQB(20),
348      5 DIC(20),YPTRB(20),DELTP,DELTMT,TNORM,SNORM,ANORM,TBVK,DBT,
349      1          I0UT,      LIN,      IQBVS,      LITER,      NORMRD,
350      1          NBV,      NEQ,      NCN,      NWRITE,      SKIP,
351      1          ITRACE,      LIMIT,      IVARY,      IAF(2),
352      1NVECT,IXTRA,
353      1JXTRA,KXTRA,N0UT,NL,NSPACE,NRCD,

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254      2NRSD,NRYD,I,II,ICOUNT,IN1,IN2,INTKEY,IPUNT,IQ,IS,ISUB,ITEMP,ITER,
355      3 J,JJ,JQ,JSUB,K,KK,KOUNT,KOUT,KQ,KTEM,MITER,NBVM,NCBL,NRANKC,
356      4 NRROWS,QBV(20),XACTBV(21),XACTIC(20),IQBV(20),NR,IQ,NE,NI
357      EQUIVALENCE (YVEC,Y),(S,SVEC),(YVEC,C),(IOUT,IBIG),(DELT,RBIG)
358  C
359  C*****ECHO THE INPUT DATA*****
360      WRITE(6,350)
361      IF(NBV)73,73,927
362      927 DO 72 I=1,NBV
363          WRITE (6,400) I,TBV(I),BV(I),QBQV(I),XACTBV(I)
364          IF(QBV(I))928,72,72
365      928      J= -QBQV(I)/100
366          K = -QBQV(I) - J*100 - 1 + J
367          WRITE (6,440) (CQBQV(M),IQBV(M),M,M=J,K)
368      72 CONTINUE
369      73 WRITE(6,450)
370      DO 74 I=1,NVECT
371      74 WRITE (6,500) I,IC(I),XACTIC(I),PTRB(I),UPPER(I),LOWER(I)
372          WRITE(6,307)IOUT,LIN,IQBV,S,LITER,NORMRD,NBV,NEQ,NCN,NWRITE,SKIP,
373          1DELT,SPTRB,PNORM,TSTART,TSTOP,NRANKC
374      360 FORMAT (4H AUX,/, (1X,8E15.7))
375          WRITE (6,360) (AUX(I),I=1,10)
376      RETURN
377      307 FORMAT (//10X,4H IOUT,I6,10X,3H LIN,I7,5HIQBV,S,I5,10X,5HLITER,I5,10X
378      1,6HNORMRD,I4//12X,3HNBV,I7,10X,3HNEQ,I7,10X,3HNCN,I7,10X,6HNWRITE,
379      2I4,10X,4HSKIP,I6//1X,4HDELT,E16.6,5X,5HSPTRB,E15.6,5X,5HPNORM,E15.
380      36,5X,6HTSTART,E14.6,5X,5HTSTOP,E15.6//10H GENERATED/10X,6HNRANKC,
381      4I4)
382      350 FORMAT(1X//16X,3HTBV,17X,3HB-V,13X,3HQBV,4X,5HXCTBV)
383      400 FORMAT (1X,I5,2(5X,E15.7),2I8)
384      440 FORMAT (30X,E15.7,3H*Y(,I4,1H),20X,I5)
385      450 FORMAT(1X//3X,3HY(,8X,2HIC,13X,5HXCTIC,10X,4HPTRB,15X,
386      15HUPPER,15X,5HLOWER)
387      500 FORMAT(4X,I2,5X,E15.7,5X,I3,4(5X,E15.7))
388  END
389  SUBROUTINE ESTABL
390  C
391      INTEGER QBV,XACTIC,SKIP,IBIG(135),XACTBV
392      REAL      RBIG(204),LOWER,SVEC( 462),LF,IC,IIC,C( 462),Y(20,21)
393      COMMON      IIC(20),IC(20),YVEC( 420),YNL( 80),LF(20),S(21,22),
394      1          DELT,      SPTRB,      PNORM,      TSTART,      TSTOP,
395      1          DET,      SMALL,      ZERO,      DETT,      TRACE,
396      2          DZERO,      CONV,      DPTRB,      DTEMP,      DN1,
397      3H,RN1,RN2,T,
398      4TAVG,TL,TN,TBMT,TEM,TEMP,TTEM,TBV( 21),BV( 20),
399      5 UPPER(20),LOWER(20),PTRB(20),AUX(10),CQBQV(20),
400      5 DIC(20),YPTRB(20),DELT,DELT,INORM,SNORM,ANORM,TBYK,DGT,
401      1          IOUT,      LIN,      IQBV,S, LITER, NORMRD,
402      1          NBV,      NEQ,      NCN,      NWRITE,      SKIP,
403      1          ITRACE,      LIMIT,      IVARY,      IAF(2),
404      1NVECT,IXTRA,
405      1JXTRA,KXTRA,NOUT,NL,NSPACE,NRCD,
406      2NRSD,NRYD,I,II,ICOUNT,IN1,IN2,INTKEY,IPUNT,IQ,IS,ISUB,ITEMP,ITER,
407      3 J,JJ,JQ,JSUB,K,KK,KOUNT,KOUT,KQ,KTEM,MITER,NBVM,NCBL,NRANKC,
408      4 NRROWS,QBV(20),XACTBV(21),XACTIC(20),IQBV(20),NR,IQ,NE,NI
409      EQUIVALENCE (YVEC,Y),(S,SVEC),(YVEC,C),(IOUT,IBIG),(DELT,RBIG)
410  C*****ESTABLISH INITIAL CONDITIONS IN YVEC*****
411      79 ITER=ITER+1
412      TRACE = 0.

```

```

413      JSUB=-NRYD
414      JQ = 0
415      DO 100 J=1,NRANKC
416      JSUB=JSUB+NRYD
417      DO 80 I=1,NVECT
418      IZ = JSUB + I
419      80 YVEC( IZ)=IC(I)
420      IF(JSUB)82,100,82
421      82 IS=JQ+J-1
422      DO 90 I=IS,NVECT
423      IF(XACTIC(I))90,92,92
424      90 JQ = JQ + 1
425      92 JJ = J - 1 + JQ
426      IZ=JSUB+JJ
427      YVEC(IZ)=YVEC(IZ)*PTRB(JJ)
428      IF(ABS(YVEC(IZ)-DPTRB))93,94,94
429      93 YVEC(IZ)=1.
430      94 YPTRB(JJ)=YVEC(IZ)
431      100 CONTINUE
432      RETURN
433      END


---


434      SUBROUTINE NGRATE
435      C
436      INTEGER QBV,XACTIC,SKIP,IBIG(135),XACTBV
437      REAL      RBIG(204),LOWER,SVEC( 462),LF,IC,IIC,C( 462),Y(20,21)
438      COMMON    IIC(20),IC(20),YVEC( 420),YNL( 80),LF(20),S(21,22),
439      1          DELT,      SPTRB,      PNORM,      TSTART,      TSTOP,
440      1          DET,      SMALL,      ZERO,      DETT,      TRACE,
441      2          DZERO,      CONV,      DPTRB,      DTEMP,      DN1,
442      3H,RN1,RN2,T,
443      4TAVG,TL,TN,TBMT,TEM,TEMP,TTEM,TBV( 21),BV( 20),
444      5 UPPER(20),LOWER(20),PRTB(20),AUX(10),CQB(20),
445      5 DIC(20),YPTRB(20),DELTP,DELTM,TNORM,SNORM,ANORM,TBVK,DET,
446      1          IOUT,      LIN,      IORVS,      LITER,      NORMRD,
447      1          NBV,      NEQ,      NCN,      NWRITE,      SKIP,
448      1          ITRACE,      LIMIT,      IVARY,      IAF(2),
449      1NVECT,IXTRA,
450      1JXTRA,KXTRA,NOUT,NL,NSPACE,NRCD,
451      2NRSD,NRYD,I,II,ICOUNT,IN1,IN2,INTKEY,IPUNT,IQ,IS,ISUB,ITEMP,ITER,
452      3 J,JJ,JQ,JSUB,K,KK,KOUNT,KOUT,KQ,KTEM,MITER,NBVM,NCOL,NRANKC,
453      4 NRWS,QBV(20),XACTBV(21),XACTIC(20),IQBV(20),NR,IG0,NE,NI
454      EQUIVALENCE (YVEC,Y),(S,SVEC),(YVEC,C),(IOUT,IBIG),(DELT,RBIG)
455      C****INTEGRATION****
456      102 KOUT=0
457      IF(IOUT-2)104,104,103
458      104 IF(ITER-MITER)929,103,103
459      103 KOUT=1
460      929 IF(IOUT-4)931,930,930
461      930 WRITE(6,630)
462      931 NI=NRWS+1
463      NE=1
464      JSUB=-NRSD
465      DO 105 I=1,NCOL
466      JSUB=JSUB+NRSD
467      105 SVEC(JSUB+1)=1.
468      TL=TSTART
469      ICOUNT=NWRITE
470      IF(ABS(TBV(1)-TSTART)-ZERO)106,106,107
471      106 ICOUNT=0

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472 107 IF(ITER=MITER)936,935,935
473 935 WRITE(6,590)
474 936 WRITE(6,600)ITER,MITER
475     INTKEY=0
476     IN1 = NRANKC
477 932 IF(MITER=ITER)933,933,934
478 933 IN1=1
479 934 K=1
480
481     TBVK = TBV(K)
482
483 110 TEM=0.
484 RETURN
485 600 FORMAT (20X,4HITER,I4,4H 0F,I4,/,10X,4HTIME,14X,8HSOLUTION)
486 630 FORMAT(1X/10X,39HREPEATED TIMES ARE PARTICULAR SOLUTIONS,/)
487 590 FORMAT(1H1)
488 END
489 SUBROUTINE STORES
490
491 C
492 C
493     STORES
494     INTEGER QBV,XACTIC,SKIP,IBIG(135),XACTBV
495     REAL      RBIG(204),LOWER,SVEC( 462),LF,IC,IIC,C( 462),Y(20,21)
496     COMMON    IIC(20),IC(20),YVEC( 420),YNL( 80),LF(20),S(21,22),
497 1      DELT,      SPTRB,      PNORM,      TSTART,      TSTOP,
498 1      DET,      SMALL,      ZERO,      DETT,      TRACE,
499 2      DZER0,      CONV,      DPTRB,      DTEMP,      DN1,
500 3H,RN1,RN2,T,
501 4TAVG,TL,TN,TBMT,TEM,TEMP,TTEM,TBV( 21),BV( 20),
502 5 UPPER(20),LOWER(20),PTRB(20),AUX(10),CQBV(20),
503 5 DIC(20),YPTRB(20),DELT,DELT,MTNORM,SNORM,ANORM,TBVK,D0T,
504 1      IOUT,      LIN,      IQBVS,      LITER,      NORMRD,
505 1      NBV,      NEQ,      NCN,      NWRITE,      SKIP,
506 1      ITRACE,      LIMIT,      IVARY,      IAF(2),
507 1NVECT,IXTRA,
508 1JXTRA,KXTRA,NOUT,NL,NSPACE,NRCD,
509 2NRSD,NRYD,I,II,ICOUNT,IN1,IN2,INTKEY,IPUNT,IQ,IS,ISUB,ITEMP,ITER,
510 3 J,JJ,JQ,JSUB,K,KK,KCOUNT,KOUT,KQ,KTEM,MITER,NBVM,NCOL,NRANKC,
511 4 NR0WS,QBV(20),XACTBV(21),XACTIC(20),IBBV(20),NR,IQ0,NE,NI
512 EQUIVALENCE (YVEC,Y),(S,SVEC),(YVEC,C),(IOUT,IBIG),(DELT,RBIG)
513 134 IF (XACTBV(K)) 152,135,135
514 135 IQ = QBV(K)
515 IF(XACTBV(K))139,138,139
516 139 NI=NI+1
517 NR=NI
518 GO TO 140
519 138 NE=NE+1
520 NR=NE
521 140 ISUB=-NRYD
522 JSUB=-NRSD
523 IF (IQ)143,143,144
524 143 J= -IQ/100
525 IS = J - (IQ + J*100) - 1
526 144 DO 150 I=1,NRANKC
527     ISUB = ISUB + NRYD
528     JSUB = JSUB + NRSD
529 IF(IQ)145,145,147
530 147 IZ = IQ + ISUB
531 D0T = YVEC(IZ)
532 GO TO 148
533 145 D0T = 0.
534 IF (IS=J)149,950,950

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531      950      DO 146 M=J,IS
532          JJ = IQBV(M)
533      IZ = JJ + JSUB
534      146      DOT = DOT + YVEC(IZ)*CQBV(M)
535      148      IZ = NR + JSUB
536          SVEC(IZ) = DOT
537      149      IF (I=NRANKC)150,951,150
538      951      IZ = NR+NRSD+JSUB
539      SVEC(IZ) = BV(K)
540      150      CONTINUE
541      151      IF(IQ)952,952,152
542      952      IF(IS=J)953,152,152
543      953      CONTINUE
544      CALL NLBC
545      152      K = K + 1
546          IF(K=NBV)154,154,153
547      153      IF(ITER=MITER)170,154,154
548      154      IF(K=NBV)954,954,955
549      954      TBVK=TBV(K)
550      GO TO 956
551      955      TBVK=TSTOP+2.*DELT
552      956      IF(ABS(TBVK-TBV(K-1)))134,134,957
553      957      TEM=TEM+TBMT
554          TEM=TEM+TBMT
555          TTEM=TL+DELT-TEM
556          IF(TEM=DELTM)155,958,958
557      958      TTEM=TL+2.*DELT-TEM
558          KTEM=KTEM+1
559          IF(KTEM=1)960,959,960
560      959      ICOUNT=ICOUNT+1
561      960      IF(ICOUNT=NWRITE)155,961,155
562      961      ICOUNT=0
563      155      INTKEY=0
564          IF(ABS(TTEM-TBVK))110,110,157
565      157      IF(TTEM-TBVK)158,158,112
566      158      H=TTEM-TL
567          I=-1
568      110      RETURN
569      170      I = 0
570      RETURN
571      112      J = 0
572      RETURN
573      END


---


574      SUBROUTINE NLBC
575      C
576      REAL      LF,DY(20),U(20)
577      COMMON      FIC(40),P(20,21),C(80),LF(20),S(21,22),
578      1          RD1(9),TRACE,RD2(5),H,RD3(2),T,RD4(7),TBV(21),BV(80),
579      2          AUX(10),CQ(67),
580      3          ID1(16),IPART,JSUB,ID2(2),NL,ID3(29),NRANKC,ID4(62),IQ(24)
581      EQUIVALENCE (TL,RD4(2)),(J,ID3(17)),(K,ID3(21)),(NR,IQ(21))
582      EQUIVALENCE (LF,DY),(P,U)
583      DO 80 ICL = 1,NRANKC
584      ASM = 0.
585      DO 79 IDX = 1,4
586      IZ=5-IDX
587      79      ASM=ASM+U(IZ)*P(IDX,ICL)
588      80      S(NR,ICL) = ASM
589      S(NR,NRANKC+1)=BV(K) = SIN(U(5)*TL)-U(1)*U(4)-U(2)*U(3)

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590      RETURN
591      END
592      SUBROUTINE NEWIC
593      C
594      C          NEWIC
595      INTEGER QBV,XACTIC,SKIP,IBIG(135),XACTBV
596      REAL      RBIG(204),LOWER,SVEC( 462),LF,IC,IIC,C( 462),Y(20,21)
597      COMMON    IIC(20),IC(20),YVEC( 420),YNL( 80),LF(20),S(21,22),
598      1          DELT,      SPTRB,      PNORM,      TSTART,      TSTOP,
599      1          DET,      SMALL,      ZERO,      DETT,      TRACE,
600      2          DZERO,      CONV,      DPTRB,      DTEMP,      DN1,
601      3H,RN1,RN2,T,
602      4TAVG,TL,TN,TBMT,TET,TEMP,TTEM,TBV( 21),BV( 20),
603      5 UPPER(20),LOWER(20),PTRB(20),AUX(10),CQB(20),
604      5 DIC(20),YPTRB(20),DELTP,DELTM,TNORM,SNORM,ANORM,TBVK,DOT,
605      1          IOUT,      LIN,      IQBVS,      LITER,      NORMRD,
606      1          NBV,      NEQ,      NCN,      NWRITE,      SKIP,
607      1          ITRACE,      LIMIT,      IVARY,      IAF(2),
608      1NVECT,IXTRA,
609      1JXTRA,KXTRA,NOUT,NL,NSPACE,NRCD,
610      2NRSD,NRYD,I,II,ICOUNT,IN1,IN2,INTKEY,IPUNT,IQ,IS,ISUB,ITEMP,ITER,
611      3 J,JJ,JQ,JSUB,K,KK,KOUNT,KOUT,KQ,KTEM,MITER,NBVM,NCOL,NRANKC,
612      4 NRWS,QBV(20),XACTBV(21),XACTIC(20),IQBV(20),NR,IQ,NE,NI
613      EQUIVALENCE (YVEC,Y),(S,SVEC),(YVEC,C),(IOUT,IBIG),(DELT,RBIG)
614      C****CALCULATE NEW INITIAL CONDITIONS****
615      IF (J) 970,188,188
616      188 KQ=0
617      ANORM = 0.
618      DOT = 0.
619      JSUB=NRANKC*NRSD
620      DO 210 J=1,NVECT
621      IF(XACTIC(J))190,195,195
622      190 KQ=KQ+1
623      GO TO 210
624      195 JJ=J+KQ+1
625      C****CALCULATE NEW J-TH ELEMENT OF INITIAL CONDITION VECTOR****
626      IZ = JJ + JSUB
627      DTEMP= SVEC(IZ)
628      DTEMP = YPTRB(J)*DTEMP + IC(J)*(1. -DTEMP)
629      TDIC = DTEMP - IC(J)
630      IF(ABS(PNORM)-ZERO)205,198,198
631      198 DTEMP=DIC(J)*0.5
632      IF(TDIC*DIC(J))199,205,205
633      199 IF (ABS(TDIC)-ABS(DTEMP)) 205,205,200
634      200 TDIC=-DTEMP
635      205 DOT = DOT + TDIC*DIC(J)
636      ANORM = ANORM + TDIC**2
637      DIC(J) = TDIC
638      210 CONTINUE
639      ANORM = SQRT(ANORM)
640      DOT = DOT/(ANORM*TNORM)
641      212 IF(PNORM)970,970,213
642      213 CONTINUE
643      J = -1
644      RETURN
645      970 IF(ANORM=SNORM)971,963,963
646      971 IF(NORMRD)963,963,962
647      962 SNORM=ANORM
648      963 TNORM=ANORM

```

```

649      DO 215 J=1,NVECT
650      IF(XACTIC(J))215,964,964
651      964      IC(J)=IC(J)+DIC(J)
652      IF(XACTIC(J)-1)214,965,965
653      965      IF(IC(J)-UPPER(J))967,967,966
654      966      IC(J)=UPPER(J)
655      967      IF(IC(J)-LOWER(J))968,214,214
656      968      IC(J)=LOWER(J)
657      214      IF(SKIP)215,969,215
658      969      IIC(J)=IC(J)
659      215      CONTINUE
660      DO 220 I=2,NRANKC
661      IZ=I+JSUB
662      IF(ABS(SVEC(IZ))-CONV)220,216,216
663      216      IF(ITER=LITER)79,220,220
664      220      CONTINUE
665      MITER=ITER+1
666      79      RETURN
667      END


---


668      SUBROUTINE MODIFY
669      C
670      INTEGER QBV,XACTBV,SKIP,IBIG(135)
671      REAL      RBIG(204),LOWER,SVEC( 462),LF,IC,IIC,C( 462),Y(20,21)
672      COMMON    IIC(20),IC(20),YVEC( 420),YNL( 80),LF(20),S(21,22),
673      1          DELT,      SPTRB,      PNORM,      TSTART,      TSTOP,
674      1          DET,      SMALL,      ZERO,      DETT,      TRACE,
675      2          DZER0,      CONV,      DPTRB,      DTEMP,      DN1,
676      3H,RN1,RN2,T,
677      4TAVG,TL,TN,TBMT,TEM,TEMP,TTEM,TBV( 21),BV( 20),
678      5 UPPER(20),LOWER(20),PTRB(20),AUX(10),CQBV(20),
679      5 DIC(20),YPTRB(20),DELT,DELT,INORM,SNORM,ANORM,TBVK,D0T,
680      1          I0UT,      LIN,      IQBVS,      LITER,      NORMRD,
681      1          NBV,      NEQ,      NCN,      NWRITE,      SKIP,
682      1          ITRACE,      LIMIT,      IVARY,      IAF(2),
683      1NVECT,IXTRA,
684      1JXTRA,KXTRA,N0UT,NL,NSPACE,NRCD,
685      2NRSD,NRYD,I,II,ICOUNT,IN1,IN2,INTKEY,IPUNT,IQ,IS,ISUB,ITEMP,ITER,
686      3 J,JJ,JQ,JSUB,K,KK,K0UNT,K0UT,KQ,KTEM,MITER,NBVM,NCOL,NRANKC,
687      4 NR0WS,QBV(20),XACTBV(20), KIC(21),IQBV(20),NR,IQ0,NE,NI
688      EQUIVALENCE (YVEC,Y),(S,SVEC),(YVEC,C),(I0UT,IBIG),(DELT,RBIG)
689      IF (ANORM=PNORM)2,4,4
690      2 IF (D0T)4,4,3
691      3 RETURN
692      4 C0EF=1.
693      IF (ANORM=PNORM)6,6,5
694      5 C0EF = PNORM/ANORM
695      6 ITEM = -PNORM/ANORM = 1.
696      IF(ITEM+10)7,8,8
697      7 ITEM=-10
698      8 IF(D0T)9,10,10
699      9 C0EF = C0EF*(1.+D0T*10.**ITEM)
700      10 DO 20 I=1,NVECT
701      IF(KIC(I))20,20,11
702      11 DIC(I) = C0EF*DIC(I)
703      20      CONTINUE
704      ANORM = ANORM*C0EF
705      RETURN
706      END


---


707      SUBROUTINE GJRWLS

```



```

708 C
709     INTEGER I(21),J(22),JZC(20),IJTV(20)
710     COMMON AD1(40),B(21,22),AD2(58),A(21,22),AD3(8),SET,TRACE,CHECK,AD
711     14(193),IOUT,ID1(21),NRB,NRA,ID2(7),IPUNT,ID3(18),N,NROWA,ID4(60),
712     2 NEMAX,ID5(24)
713     EQUIVALENCE (AD2(39),IJTV)
714     NTOTAL = N + 1
715     LSTOP=NEMAX
716     NROW=NROWA
717     NEND=NROWA
718     IF(NROWA=NTOTAL)20,30,30
719     20 NEND=NTOTAL
720     30 DO 100 L=1,NEND
721     IF(L=NTOTAL)40,40,100
722     40 J(L)=L
723     100 I(L)=L
724     DO 650 K=1,N
725     C=0.0
726     DO 200 L=K,LSTOP
727     IL = I(L)
728     DO 200 M = K, N
729     JM=J(M)
730     ABSA=ABS(A(IL,JM))
731     IF(ABSA=C)200,200,190
732     190 KL = L
733     KM = M
734     C = ABSA
735     200 CONTINUE
736     KI = I(KL)
737     KJ = J(KM)
738     I(KL) = I(K)
739     I(K) = KI
740     J(KM) = J(K)
741     J(K) = KJ
742     AKK = A(KI,KJ)
743     A(KI,KJ)=1.
744     DET = DET*AKK
745     IF(NEMAX=N)260,260,250
746     250 IF(K=N)260,1400,1400
747     260 IF(C=CHECK)345,345,350
748     345 CONTINUE
749     IPUNT = 2
750     RETURN
751     350 AD2(K+18)=AKK
752     IJTV(K)= 100*KI+KJ
753     370 AKK=1.E0/AKK
754     KP1=K+1
755     DO 400 M=KP1,NTOTAL
756     JM=J(M)
757     400 A(KI,JM)=AKK*A(KI,JM)
758     DO 600 L=1,NROW
759     IF(L=K)420,600,420
760     420 IL=I(L)
761     AKK = A(IL,KJ)
762     A(IL,KJ)=0.
763     DO 500 M=KP1,NTOTAL
764     JM = J(M)
765     500 A(IL,JM) = A(IL,JM) - AKK*A(KI,JM)
766     600 CONTINUE

```

```

767      IF(K=NEMAX)650,610,650
768      610 IF(N=K)650,650,620
769      620 DO 621 L = 1,N
770          JZC(L) = 0
771          DO 621 M=1,NTOTAL
772      621 B(L,M) = 0.
773          DO 627 L=KP1,N
774          IRAT = J(L)
775          JZC(IRAT) = 1
776          DO 626 M=KP1,NTOTAL
777          JCA = J(M)
778          IF (IRAT-JCA) 622,622,626
779      622 TEMP = 0.
780          DO 623 KR = KP1,NROWA
781      623 TEMP = TEMP + A(KR,IRAT)*A(KR,JCA)
782          B(IRAT,JCA) = TEMP
783          IF (IRAT-JCA) 624,626,626
784      624 IF (JCA=N) 625,625,626
785      625 B(JCA,IRAT) = TEMP
786      626 CONTINUE
787      627 CONTINUE
788          IRA = K
789          DO 630 L = 1,N
790          IF (JZC(L)) 628,630,628
791      628 IRA = IRA + 1
792          DO 629 M = KP1,NTOTAL
793          JCA = J(M)
794      629 A(IRA,JCA) = B(L,JCA)
795      630 CONTINUE
796          LSTOP = N
797          NROW = N
798      650 CONTINUE
799          DO 1000 K=1,N
800          KI = I(K)
801          KJ = J(K)
802          IF(KI=KJ)660,800,660
803      660 DO 700 M=1,NTOTAL
804          AKK=A(KI,M)
805          A(KI,M) = A(KJ,M)
806      700 A(KJ,M) = AKK
807      800 DO 900 L = K,N
808          IF(I(L)=J(K))900,950,900
809      900 CONTINUE
810      950 I(L) = I(K)
811      1000 I(K) = L
812      1400 CONTINUE
813      1450 IPUNT=1
814          RETURN
815      END

```

---

```

816      SUBROUTINE UNETEN
817      C
818          INTEGER QBV,XACTIC,SKIP,IBIG(135),XACTBV
819          REAL      RBIG(204),LOWER,SVEC( 462),LF,IC,IIC,C( 462),Y(20,21)
820          COMMON    IIC(20),IC(20),YVEC( 420),YNL( 80),LF(20),S(21,22),
821      1              DELT,      SPTRB,      PNORM,      TSTART,      TSTOP,
822      1              DET,      SMALL,      ZERO,      DETT,      TRACE,
823      2              DZERO,      CONV,      DPTRB,      DTEMP,      DN1,
824      3H,RN1,RN2,T,
825      4TAVG,TL,TN,TBMT,TEM,TEMP,TTEM,TBV( 21),BV( 20),

```

```

826      5 UPPER(20),LOWER(20),PRTB(20),AUX(10),CQBV(20),
827      5 DIC(20),YPTRB(20),DELTP,DELTM,TNORM,SNORM,ANORM,TBVK,DST,
828      1      IOUT,      LIN,      IQBVS,      LITER,      NORM-D,
829      1      NBV,      NEQ,      NCN,      NWRITE,      SKIP,
830      1      ITRACE,      LIMIT,      IVARY,      IAF(2),
831      1NVECT,IXTRA,
832      1JXTRA,KXTRA,NOUT,NL,NSPACE,NRCD,
833      2NRSD,NRYD,I,II,ICOUNT,IN1,IN2,INTKEY,IPUNT,IQ,IS,ISUB,ITEMP,ITER,
834      3 J,JJ,JQ,JSUB,K,KK,KOUNT,KOUT,KQ,KTEM,MITER,NBVM,NCOL,NRANKC,
835      4 NRQWS,QBV(20),XACTBV(21),XACTIC(20),IQBV(20),NR,IQ0,NE,NI
836      EQUIVALENCE (YVEC,Y),(S,SVEC),(YVEC,C),(IOUT,IBIG),(DELT,RBIG)
837      GO TO (111,105,105,105),IVARY
838      105 IF (J) 106,112,106
839      106 IF (I) 118,110,110
840      110 TEM = 0.
841      KTEM=0
842      IF (TL-TSTOP ) 937,937,135
843      937 IF(ICOUNT=NWRITE)112,938,938
844      938 IQ0=1
845      109 IF(KOUT=1)939,940,940
846      939 IF(ABS(TL-TSTART))940,940,941
847      941 GO TO (111,134),IQ0
848      940 NOUT=NEQ
849      IF(ABS(TL-TSTART))942,942,943
850      942 NOUT=NVECT
851      943 CONTINUE
852      IVARY = 1
853      RETURN
854      111 ICOUNT=0
855      112 TBMT = TBVK - TL
856      IF(TBMT=DELTP)115,115,114
857      115 INTKEY=1
858      H=TBMT
859      GO TO 118
860      114 H=DELT
861      118 T = TL + H
862      CALL DOUT
863      TL=TL+H
864      IF(INTKEY=1)131,130,131
865      131 ICOUNT=ICOUNT+1
866      GO TO 110
867      130 IQ0 = 2
868      GO TO 109
869      134 IVARY = 2
870      RETURN
871      135 IVARY = 3
872      RETURN
873      END


---


874      SUBROUTINE DOUT
875      C
876      REAL      YK(20),YP(20),A(3),TN(4),B(3),LF
877      COMMON    DD1( 40), Y( 420), C(80),LF(20),SVEC(462),
878      1      RD1(15),HH,RD2(4),T,RD3(183),
879      2      IOUT,LIN,ID1(4),NEQ,ID2(8),NVECT,IPART,JSUB,
880      3      ID3(2),NL,ID4(3),NRYD,ID5(3),IN1,ID6(108)
881      DATA A/1.,2.,2./
882      IPART=0
883      ISUB=NRYD
884      IQ0=0

```

```

885      1 IPART=IPART+1
886      TI=T
887      IF(IPART=IN1)3,3,2
888      2 RETURN
889      3 ISUB=ISUB+NRYD
890      H=HH
891      NL=1
892      IF(IPART=1)101,102,101
893 101 IF(LIN)103,103,102
894 102 NL=0
895 103 IF(IPART=1) 104,104,15
896 104 IF(LIN)105,105,15
897 105 H= HH/2,E0
898      4 IPT = IG0*NRYD
899      D0 5 I = 1,NVECT
900      IZ = IPT + I
901      5 C(IZ) = Y(I)
902      IG0=IG0+1
903      IF(IG0=2)15,15,1
904 15 D0 20 I=1,NVECT
905      IZ = ISUB + I
906      YK(I) = Y(IZ)
907      YP(I) = 0.
908 20 CONTINUE
909      H06 = H/6.
910      B(1) = H/2.
911      B(2)=B(1)
912      B(3)=H
913      TN(1)=TI
914      TN(2)=TI+B(1)
915      TN(3)=TN(2)
916      TN(4)=TI+H
917      JSUB=1
918      D0 30 J=1,4
919      IF(J=3)106,107,106
920 106 JSUB=JSUB+1
921 107 IPT = JSUB*NRYD+1
922      CALL RHS (YK,C(IPT),C(IPT),TN(J))
923      IF(J=4)25,50,25
924 25 D0 30 I=1,NEQ
925      YP(I)=YP(I)+A(J)*LF(I)
926      IZ = ISUB + I
927 30 YK(I) = Y(IZ) + B(J)*LF(I)
928 50 D0 60 I=1,NEQ
929      IZ=ISUB+I
930 60 Y(IZ) = Y(IZ) + H06*(YP(I)+LF(I))
931      IF(IPART=1)65,65,1
932 65 IF(LIN)68,68,1
933 68 TI=TN(4)
934      G0 T0 4
935      END

```

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OF POOR QUALITY

```

936      SUBROUTINE RHS(Y,Y0,Y0,TN)
937  C
938      REAL      Y0(20),Y0(20),LF,DY(20),U(20),Y(20)
939      COMMON    FIC(40),P(20,21),C(80),LF(20),S(21,22),
940      1          RD1(9),TRACE,RD2(5),H,RD3(2),T,RD4(7),TBV(21),BV(80),
941      2          AUX(10),CQ(67),
942      3          ID1(16),IPART,JSUB,ID2(2),NL,ID3(29),NRANKC,ID4(62),IQ(24)
943      EQUIVALENCE (LF,DY),(P,U)

```

```

944      NRC = 20
945      IF(NL)45,45,50
946      C
947      C      HERE ARE THE NON=LINEAR (OR LINEAR) EQUATIONS
948      C
949      45 CONTINUE
950      DY(1) = Y(2)
951      DY(2) = -Y(1)*Y(4)-Y(2)*Y(3)+SIN(Y(5)*TN)
952      47 RETURN
953      50 CONTINUE
954      C
955      C      HERE ARE THE LINEARIZED EQUATIONS
956      C
957      LF(1) = Y(2)
958      LF(2)=-Y0(1)*Y(4)-Y0(2)*Y(3)-Y0(3)*(Y(2)-Y0(2))-Y0(4)*(Y(1)-Y0(1))
959      1      +SIN(Y0(5)*TN)
960      RETURN
961      END


---


962      SUBROUTINE WRITES
963      INTEGER IJTV(20)
964      INTEGER QBV,XACTIC,SKIP,IBIG(135),XACTRV
965      REAL      RBIG(204),LOWER,SVEC( 462),LF,IC,IIC,C( 462),Y(20,21)
966      COMMON      IIC(20),IC(20),YVEC( 420),YNL( 80),LF(20),S(21,22),
967      1      DELT,      SPTRB,      PNORM,      TSTART,      TSTOP,
968      1      DET,      SMALL,      ZERO,      DETT,      TRACE,
969      2      DZERO,      CONV,      DPTRB,      DTEMP,      DN1,
970      3H,RN1,RN2,T,
971      4TAVG,TL,TN,TBMT,TEM,TEMP,TTEM,TBV( 21),BV( 20),
972      5 UPPER(20),LOWER(20),PTRB(20),AUX(10),CQB(20),
973      6DIC(20),YTPRB(20),DELT,DELT,TDNORM,SNORM,ANORM,TBVK,DOT,
974      1      IOUT,      LIN,      IQBVS,      LITER,      NORMRD,
975      1      NBV,      NEG,      NCN,      NWRITE,      SKIP,
976      1      ITRACE,      LIMIT,      IVARY,      IAF(2),
977      1NVECT,IXTRA,
978      1JXTRA,KXTRA,NOUT,NL,NSPACE,NRCD,
979      2NRSD,NRYD,1,II,ICOUNT,IN1,IN2,INTKEY,IPUNT,IQ,IS,ISUB,ITEMP,ITER,
980      3 J,JJ,JQ,JSUB,K,KK,KCOUNT,KOUT,KQ,KTEM,MITER,NBVM,NCOL,NRANKC,
981      4 NRQWS,QBV(20),XACTBV(21),XACTIC(20),IQBV(20),NR,IQ0,NE,NI
982      EQUIVALENCE (YVEC,Y),(S,SVEC),(YVEC,C),(IOUT,IBIG),(DELT,RBIG)
983      EQUIVALENCE (LF,IJTV)
984      C      WRITES SHOULD NOT BE ENTERED WITH LIMIT = 3
985      GO TO (172,200,200,230),LIMIT
986      172 IF(IOUT=1)182,174,174
987      174 WRITE(6,550)
988      DO 180 I=1,NRQWS
989      180 WRITE (6,800) I,S(I,NCOL),(S(I,J),J=1,NRANKC)
990      182 RETURN
991      200 IF (IPUNT=2) 201,205,201
992      201 CONTINUE
993      IF (IOUT=1) 182,182,202
994      202 DO 203 I=1,NRANKC
995      203 WRITE(6,360) I,YNL(I+60),IJTV(I)
996      WRITE(6,650) (S(I,NCOL),I=1,NRANKC)
997      211 WRITE(6,370)DOT,ANORM
998      WRITE(6,380)(DIC(I),I=1,NVECT)
999      RETURN
1000      205 LIMIT = 3
1001      345 WRITE (6,340)
1002      RETURN

```

```

1003      230 M=1
1004      IF (IOUT=3) 232,232,231
1005      231 IF (ITER=MITER) 234,232,232
1006      234 M = NRANKC
1007      232 DO 233 J=1,M
1008      233 WRITE(6,700) IAF(IG0),TL,(Y(I,J),I=1,NOUT)
1009      RETURN
1010      340 FORMAT(44H PUNT... ILL CONDITIONED IPUNT RETURNED AS 2)
1011      360 FORMAT(10X,15,8HPIVOT,E15.6,I6)
1012      370 FORMAT (1X/3X,4HDOT ,E15.7,15X,7H ANORM,E15.7)
1013      380 FORMAT (/ ,11H DIC VECTOR,/(1X, 7E15.7))
1014      550 FORMAT (1X// 2X,11HSAVE MATRIX,/
1015      1 5X,46HBOUNDARY VALUE,UNPTRBD SOLN, PTRBD SOLNS.....)
1016      650 FORMAT(1X/3X,11HCONSTANTS , 7E15.7/(14X, 7E15.7))
1017      700 FORMAT (1X,A2,8E15.7/(20X,7E15.7))
1018      800 FORMAT(3X,I2, 7E14.6/(5X, 7E14.6))
1019      END

```

### EXAMPLE APPLICATION

To illustrate in an explicit fashion the use of the program and, in particular, the programming of the governing equations, consider the damped harmonic oscillator with an impressed forcing function.

$$\ddot{x}(t) + \mu \dot{x}(t) + \xi x(t) = \sin \omega t$$

the second order equation is converted to a system of two first order equations by the transformation

$$y_1(t) = x(t)$$

$$y_2(t) = \dot{x}(t)$$

The resulting system is seen to be

$$\dot{y}_1(t) = y_2(t)$$

$$\dot{y}_2(t) = \sin \omega t - \mu y_2(t) - \xi y_1(t)$$

For purposes of identifying the parameters  $\mu$ ,  $\xi$  and  $\omega$  from an observed response of the system to a given excitation, let us denote these constants as variables, i.e., elements of a state variable vector,

$$y_3 = \mu$$

$$y_4 = \xi$$

$$y_5 = \omega$$

It follows that those "variables" obey the equations

$$\dot{y}_3(t) = 0$$

$$\dot{y}_4(t) = 0$$

$$\dot{y}_5(t) = 0$$

Note that:

- a) if  $\mu$ ,  $\xi$  and  $\omega$  are specified then the system

$$\dot{y}_1 = y_2$$

$$\dot{y}_2 = \sin y_5(t) - y_3(t) \cdot y_2(t) - y_4(t) \cdot y_1(t)$$

$$\dot{y}_3 = 0 \quad y_3(0) = \mu$$

$$\dot{y}_4 = 0 \quad y_4(0) = \xi$$

$$\dot{y}_5 = 0 \quad y_5(0) = \omega$$

is linear or nonlinear, as you wish to call it.

- b) If say,  $\mu$  and  $\xi$  are not specified, then the same system is nonlinear for the identification problem. In such a case, the linearized system is constructed from a previous approximation  $y_0$  to be

$$\dot{y}_1 = y_2(t)$$

$$\dot{y}_2 = \sum_{j=1}^2 a_{2j}(t) \cdot y_j(t) + f_2(t)$$

$$\dot{y}_3 = 0$$

$$\dot{y}_4 = 0$$

$$\dot{y}_5 = 0$$



where

$$f_2(t) = \sin \omega t - y_{o_3}(t) \cdot y_{o_2}(t) - y_{o_4}(t) \cdot y_{o_1}(t) - \sum_{j=1}^4 a_{2j}^o(t) \cdot y_{o_j}(t)$$

with

$$a_{2j}^o(t) = \frac{\partial}{\partial y_j} [\sin \omega t - y_3(t) \cdot y_2(t) - y_4(t) \cdot y_1(t)] \Big|_{y = y_o} \quad (5.9)$$

such that

$$a_{21}^o(t) = -y_{o_4}(t)$$

$$a_{22}^o(t) = -y_{o_3}(t)$$

$$a_{23}^o(t) = -y_{o_2}(t)$$

$$a_{24}^o(t) = -y_{o_1}(t)$$

The nonlinear system can be programmed as

$$DY(1) = Y(2)$$

$$DY(2) = \sin(Y(5) \cdot T) - Y(2) \cdot Y(3) - Y(1) \cdot Y(4).$$

The linearized system can be programmed as

$$LF(1) = Y(2)$$

$$\begin{aligned} LF(2) = & \sin(YO(5) \cdot T) - YO(2) \cdot YO(3) - YO(4) \cdot YO(1) \\ & + (Y(1) - YO(1)) \cdot (-YO(4)) \\ & + (Y(2) - YO(2)) \cdot (-YO(3)) \\ & + (Y(3) - YO(3)) \cdot (-YO(2)) \\ & + (Y(4) - YO(4)) \cdot (-YO(1)). \end{aligned}$$

# SAMPLE INPUT

# SAMPLE PROBLEM #1

INPUT DATA CARD 4 20  
INPUT DATA CARD 6 15  
INPUT DATA CARD 7 2  
INPUT DATA CARD 8 3

BLANK DATA CARD

INPUT DATA CARD 1 0.2000000E+01  
INPUT DATA CARD 12 0.9999999E+04

BLANK DATA CARD

INPUT DATA CARD 1 0 0.1000000E+01 -0.2700000E+00 1  
INPUT DATA CARD 2 0 0.2000000E+01 0.3500000E+01 1  
INPUT DATA CARD 3 0 0.3000000E+01 -0.4740000E+00 1  
INPUT DATA CARD 4 0 0.4000000E+01 -0.5890000E+00 1  
INPUT DATA CARD 5 0 0.5000000E+01 0.3929999E+00 1  
INPUT DATA CARD 6 0 0.6000000E+01 0.1596999E+01 1  
INPUT DATA CARD 7 0 0.7000000E+01 0.1452000E+01 1  
INPUT DATA CARD 8 0 0.8000000E+01 -0.3880000E+00 1  
INPUT DATA CARD 9 0 0.9000000E+01 -0.2323999E+01 1  
INPUT DATA CARD 10 0 0.1000000E+02 -0.2273999E+01 1  
INPUT DATA CARD 11 0 0.1100000E+02 0.8800000E+01 1  
INPUT DATA CARD 12 0 0.1200000E+02 0.2710999E+01 1  
INPUT DATA CARD 13 0 0.1300000E+02 0.2997000E+01 1  
INPUT DATA CARD 14 0 0.1400000E+02 0.4010000E+00 1  
INPUT DATA CARD 15 0 0.1500000E+02 -0.2816000E+01 1

BLANK DATA CARD

INPUT DATA CARD 1 0 0.5000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00  
INPUT DATA CARD 2 0 0.1000000E+01 0.0000000E+00 0.0000000E+00 0.0000000E+00  
INPUT DATA CARD 3 0 0.9999999E+01 0.0000000E+00 0.0000000E+00 0.0000000E+00  
INPUT DATA CARD 4 0 0.2999999E+01 0.0000000E+00 0.0000000E+00 0.0000000E+00  
INPUT DATA CARD 5 -1 0.1000000E+01 0.0000000E+00 0.0000000E+00 0.0000000E+00

BLANK DATA CARD

ORIGINAL PAGE IS  
OF POOR  
QUALITY

	TBV	B-V	GBV	XCTBV
1	0.1000000E+01	-0.2200000E+00	0	1
2	0.2000000E+01	0.3500000E+01	0	1
3	0.3000000E+01	-0.4740000E+00	0	1
4	0.4000000E+01	-0.5890000E+00	0	1
5	0.5000000E+01	0.3929999E+00	0	1
6	0.6000000E+01	0.1596999E+01	0	1
7	0.7000000E+01	0.1452000E+01	0	1
8	0.8000000E+01	-0.3880000E+00	0	1
9	0.9000000E+01	-0.2323999E+01	0	1
10	0.1000000E+02	-0.2273999E+01	0	1
11	0.1100000E+02	0.8800000E+01	0	1
12	0.1200000E+02	0.2710999E+01	0	1
13	0.1300000E+02	0.2997000E+01	0	1
14	0.1400000E+02	0.4010000E+00	0	1
15	0.1500000E+02	-0.2816000E+01	0	1

Y(I)	IC	XCTIC	PTRB	UPPER	LOWER
1	0.5000000E+00	0	0.1200000E+01	0.0000000E+00	0.0000000E+00
2	0.1000000E+01	0	0.1200000E+01	0.0000000E+00	0.0000000E+00
3	0.9999996E-01	0	0.1200000E+01	0.0000000E+00	0.0000000E+00
4	0.1299999E+01	0	0.1200000E+01	0.0000000E+00	0.0000000E+00
5	0.1000000E+01	-1	0.0000000E+00	0.0000000E+00	0.0000000E+00

IOUT 0 IIN 0 IOBVS 0 LITER 20 NORMRD 0  
 NBV 15 NEQ 2 NCN 3 NWRITE 5 SKIP 0  
 DELT 0.200000E-01 SPIRB 0.120000E+01 PNORM 0.000000E+00 TSTART 0.000000E+00 TSTOP 0.150000E+02

# SAMPLE OUTPUT

GENERATED

NRANKC 5

AUX

0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00  
 0.0000000E+00 0.0000000E+00

ITER 1 OF 20  
TIME SOLUTION

0.0000000E+00 0.5000000E+00 0.1000000E+01 0.9999996E-01 0.1299999E+01 0.1000000E+01

ITER 2 OF 20  
TIME SOLUTION

0.0000000E+00 0.8341141E+00 0.5481580E-01 0.3672228E+00 0.1158999E+01 0.1000000E+01

ITER 3 OF 20  
TIME SOLUTION

0.0000000E+00 -0.220699E+00 0.2258086E+01 0.1949387E+00 0.8618612E+00 0.1000000E+01

ITER 4 OF 20  
TIME SOLUTION

0.0000000E+00 -0.5682859E+00 0.3256903E+00 0.2366757E+00 0.9794848E+00 0.1000000E+01

ITER 5 OF 20  
TIME SOLUTION

0.0000000E+00 0.1362946E+01 0.3176879E+00 0.2017888E+00 0.1000775E+01 0.1000000E+01

ITER 6 OF 20  
TIME SOLUTION

0.0000000E+00 0.9985237E+00 0.5017281E+00 0.1999071E+00 0.9998708E+00 0.1000000E+01

ITER 7 OF 20  
TIME SOLUTION

0.0000000E+00 0.100209E+01 0.5021760E+00 0.1999351E+00 0.9998615E+00 0.1000000E+01

ITER 8 OF 20  
TIME SOLUTION

0.0000000E+00 0.1001977E+01 0.5020004E+00 0.1999393E+00 0.9998688E+00 0.1000000E+01

ITER 9 NF 9		SOLUTION			
TIME					
0.000000E+00	0.100198E+01	-0.5020053E+00	0.1999387E+00	0.9998682E+00	0.1000000E+01
0.9999996E-01	0.1046790E+01	0.3995273E+00			
0.1999999E+00	0.1081347E+01	0.2970799E+00			
0.2999998E+00	0.1106408E+01	0.2073300E+00			
0.3999997E+00	0.1123111E+01	0.1267487E+00			
0.4999996E+00	0.1132145E+01	0.5561259E-01			
0.5999995E+00	0.1134542E+01	-0.5991302E-02			
0.6999994E+00	0.1131251E+01	-0.5815910E-01			
0.7999993E+00	0.1123205E+01	-0.1011595E+00			
0.8999992E+00	0.1111300E+01	-0.1354223E+00			
BV 0.1000000E+01	0.1096383E+01	-0.1615243E+00			
1TH BV =0.2200000E+00	U(Y) =0.2224722E+00				
0.1099998E+01	0.1079234E+01	-0.1801722E+00			
0.1199995E+01	0.1060560E+01	-0.1921865E+00			
0.1299993E+01	0.1040975E+01	-0.1984817E+00			
0.1399990E+01	0.1021013E+01	-0.2000461E+00			
0.1499988E+01	0.1001084E+01	-0.1973221E+00			
0.1599985E+01	0.9815115E+00	-0.1931845E+00			
0.1699983E+01	0.9624978E+00	-0.1869200E+00			
0.1799980E+01	0.9441419E+00	-0.1802057E+00			
0.1899978E+01	0.9264361E+00	-0.1740888E+00			
BV 0.2000000E+01	0.9092662E+00	-0.1695670E+00			
2TH BV =0.3500000E-01	U(Y) =0.3405410E-01				
0.2099998E+01	0.8924338E+00	-0.1675733E+00			
0.2199995E+01	0.8756336E+00	-0.1689528E+00			
0.2299993E+01	0.8585002E+00	-0.1744520E+00			
0.2399990E+01	0.8405850E+00	-0.1847030E+00			
0.2499988E+01	0.8213884E+00	-0.2002143E+00			
0.2599985E+01	0.8003575E+00	-0.2213570E+00			
0.2699983E+01	0.7769207E+00	-0.2483621E+00			
0.2799980E+01	0.7504862E+00	-0.2813123E+00			
0.2899978E+01	0.7204616E+00	-0.3201411E+00			
BV 0.3000000E+01	0.6862594E+00	-0.3646433E+00			
3TH BV =0.4740000E+00	U(Y) =0.4721429E+00				
0.3099998E+01	0.6473477E+00	-0.4144333E+00			
0.3199995E+01	0.6032124E+00	-0.4690139E+00			
0.3299993E+01	0.5534061E+00	-0.5277419E+00			
0.3399990E+01	0.4975510E+00	-0.5893474E+00			
0.3499988E+01	0.4353590E+00	-0.6544446E+00			
0.3599985E+01	0.3666114E+00	-0.7205452E+00			
0.3699983E+01	0.2912290E+00	-0.7870732E+00			
0.3799980E+01	0.2092201E+00	-0.8528810E+00			
0.3899978E+01	0.1207164E+00	-0.9167672E+00			
BV 0.4000000E+01	0.2594789E-01	-0.9775091E+00			
4TH BV =0.5890000E+00	U(Y) =0.5873049E+00				
0.4099998E+01	0.7466060E-01	-0.1033821E+01			
0.4199995E+01	-0.1606273E+00	-0.1084472E+01			
0.4299993E+01	-0.2913247E+00	-0.1126238E+01			
0.4399990E+01	-0.4060053E+00	-0.1163938E+01			
0.4499988E+01	-0.5238056E+00	-0.1190456E+01			
0.4599985E+01	-0.6437552E+00	-0.1206755E+01			
0.4699983E+01	-0.7647842E+00	-0.1211902E+01			
0.4799980E+01	-0.8857359E+00	-0.1205082E+01			
0.4899978E+01	-0.1005374E+01	-0.1185610E+01			
BV 0.5000000E+01	-0.1122442E+01	-0.1152945E+01			
5TH BV =0.3929999E+00	Q(Y) =0.3938884E+00				

0.5099948E+01	-0.1235535E+01	-0.1106721E+01
0.5199995E+01	-0.1343318E+01	-0.1046728E+01
0.5299993E+01	-0.1444412E+01	-0.9729415E+00
0.5399990E+01	-0.1537444E+01	-0.8855130E+00
0.5499988E+01	-0.1621064E+01	-0.7847824E+00
0.5599985E+01	-0.1693966E+01	-0.6712782E+00
0.5699983E+01	-0.1754907E+01	-0.5457152E+00
0.5799980E+01	-0.1802727E+01	-0.4089893E+00
0.5899978E+01	-0.1836363E+01	-0.2621717E+00
BV 0.6000000E+01	-0.1854862E+01	-0.1064612E+00
6TH BV 0.1596999E+01	Q(Y)	0.1596487E+01
0.6099998E+01	-0.1857403E+01	0.5667403E+01
0.6199995E+01	-0.1843321E+01	0.2257376E+00
0.6299993E+01	-0.1812106E+01	0.3990713E+00
0.6399990E+01	-0.1763417E+01	0.5749087E+00
0.6499988E+01	-0.1697046E+01	0.7513946E+00
0.6599985E+01	-0.1613173E+01	0.9266071E+00
0.6699983E+01	-0.1511873E+01	0.1098574E+01
0.6799980E+01	-0.1393623E+01	0.1265304E+01
0.6899978E+01	-0.1259646E+01	0.1424815E+01
BV 0.7000000E+01	-0.1108921E+01	0.1575169E+01
7TH BV 0.1452000E+01	Q(Y)	0.1450824E+01
0.7099998E+01	-0.9443406E+00	0.1714379E+01
0.7199995E+01	-0.7664738E+00	0.1840643E+01
0.7299993E+01	-0.5767014E+00	0.1952210E+01
0.7399990E+01	-0.3765752E+00	0.2047459E+01
0.7499988E+01	-0.1678028E+00	0.2124904E+01
0.7599985E+01	-0.4776811E+01	0.2183222E+01
0.7699983E+01	0.2681658E+00	0.2221274E+01
0.7799980E+01	0.4913152E+00	0.2238115E+01
0.7899978E+01	0.7150569E+00	0.2239017E+01
BV 0.8000000E+01	0.9372235E+00	0.2265469E+01
8TH BV 0.3880000E+00	Q(Y)	-0.3887004E+00
0.8099998E+01	0.1155443E+01	0.2155214E+01
0.8199995E+01	0.1367499E+01	0.2082231E+01
0.8299993E+01	0.1571130E+01	0.1985742E+01
0.8399990E+01	0.1764106E+01	0.1869228E+01
0.8499988E+01	0.1944255E+01	0.1730418E+01
0.8599985E+01	0.2109501E+01	0.1571290E+01
0.8699983E+01	0.2257870E+01	0.1393060E+01
0.8799980E+01	0.2387518E+01	0.1197179E+01
0.8899978E+01	0.2496763E+01	0.9853167E+00
BV 0.9000000E+01	0.2584121E+01	0.7592960E+00
9TH BV 0.2323999E+01	Q(Y)	-0.2323474E+01
0.9099998E+01	0.2648235E+01	0.5212857E+00
0.9199995E+01	0.2682040E+01	0.2734633E+00
0.9299993E+01	0.2702671E+01	0.1820665E+01
0.9399990E+01	0.2691508E+01	-0.2419837E+00
0.9499988E+01	0.2654137E+01	-0.5045104E+00
0.9599985E+01	0.2596006E+01	-0.7667056E+00
0.9699983E+01	0.2506938E+01	-0.1025858E+01
0.9799980E+01	0.2385620E+01	-0.1279242E+01
0.9899978E+01	0.2245364E+01	-0.1524151E+01
BV 0.1000000E+02	0.2081108E+01	-0.1757979E+01
10TH BV 0.2273999E+01	Q(Y)	-0.2273366E+01
0.1010000E+02	0.1894177E+01	-0.1978025E+01
0.1020000E+02	0.1686032E+01	-0.2181865E+01
0.1029999E+02	0.1458412E+01	-0.2367146E+01
0.1039999E+02	0.1213286E+01	-0.2531680E+01

ORIGINAL PAGE IS  
OF POOR  
QUALITY

	0.1049999E+02	0.9528285E+00	-0.2673456E+01
	0.1059999E+02	0.6794098E+00	-0.2790683E+01
	0.1069998E+02	0.3955621E+00	-0.2881793E+01
	0.1079998E+02	0.1039653E+00	-0.2945473E+01
	0.1089998E+02	-0.1925829E+00	-0.2980678E+01
BV	0.1100000E+02	-0.4912672E+00	-0.2986642E+01
11TH BV	0.8800000E+01	Q(Y)	0.8835757E+01
	0.1110000E+02	-0.7889924E+00	-0.2962896E+01
	0.1120000E+02	-0.1082849E+01	-0.2909283E+01
	0.1129999E+02	-0.1369852E+01	-0.2825947E+01
	0.1139999E+02	-0.1647054E+01	-0.2713345E+01
	0.1149999E+02	-0.1911565E+01	-0.2572243E+01
	0.1159999E+02	-0.2160582E+01	-0.2403715E+01
	0.1169998E+02	-0.2391431E+01	-0.2209130E+01
	0.1179998E+02	-0.2601585E+01	-0.1950145E+01
	0.1189998E+02	-0.2788701E+01	-0.1748688E+01
BV	0.1200000E+02	-0.2950674E+01	-0.1486877E+01
12TH BV	0.2710999E+01	Q(Y)	0.2710996E+01
	0.1210000E+02	-0.3085514E+01	-0.1207262E+01
	0.1220000E+02	-0.3191608E+01	-0.9124132E+00
	0.1229999E+02	-0.3267573E+01	-0.6051509E+00
	0.1239999E+02	-0.3312315E+01	-0.2884501E+00
	0.1249999E+02	-0.3325042E+01	0.3455169E+01
	0.1259999E+02	-0.3305285E+01	0.3607383E+00
	0.1269998E+02	-0.3252892E+01	0.6867484E+00
	0.1279998E+02	-0.3168043E+01	0.1003307E+01
	0.1289998E+02	-0.3051248E+01	0.1325108E+01
BV	0.1300000E+02	-0.2903307E+01	0.1638962E+01
13TH BV	0.2997000E+01	W(Y)	0.2996999E+01
	0.1310000E+02	-0.2725456E+01	0.1923523E+01
	0.1320000E+02	-0.2519141E+01	0.2139775E+01
	0.1329999E+02	-0.2286139E+01	0.2456767E+01
	0.1339999E+02	-0.2028517E+01	0.2691709E+01
	0.1349999E+02	-0.1748612E+01	0.2902020E+01
	0.1359999E+02	-0.1449007E+01	0.3085340E+01
	0.1369998E+02	-0.1132507E+01	0.3239571E+01
	0.1379998E+02	-0.8021181E+00	0.3362888E+01
	0.1389998E+02	-0.4610092E+00	0.3455771E+01
BV	0.1400000E+02	-0.1124002E+00	0.3511023E+01
14TH BV	0.4010000E+00	Q(Y)	0.4010027E+00
	0.1410000E+02	0.2401282E+00	0.3533746E+01
	0.1420000E+02	0.5931799E+00	0.3521432E+01
	0.1429999E+02	0.9432398E+00	0.3473910E+01
	0.1439999E+02	0.1286790E+01	0.3391363E+01
	0.1449999E+02	0.1620354E+01	0.3274336E+01
	0.1459999E+02	0.1940528E+01	0.3123730E+01
	0.1469998E+02	0.2244011E+01	0.2940795E+01
	0.1479998E+02	0.2527653E+01	0.2727118E+01
	0.1489998E+02	0.2788466E+01	0.2484614E+01
BV	0.1500000E+02	0.3023731E+01	0.2215436E+01
15TH BV	-0.2816000E+01	Q(Y)	-0.2815995E+01

# SAMPLE INPUT

# SAMPLE PROBLEM #2

INPUT DATA CARD 4 10  
INPUT DATA CARD 8 3  
INPUT DATA CARD 7 2  
INPUT DATA CARD 1 4  
INPUT DATA CARD 9 25  
INPUT DATA CARD 6 11

BLANK DATA CARD

INPUT DATA CARD 1 0.2000000E+01  
INPUT DATA CARD 5 0.1500000E+02  
INPUT DATA CARD 12 0.9999999E+03

BLANK DATA CARD

INPUT DATA CARD 1 1 0.1000000E+01 0.1093660E+01 1  
INPUT DATA CARD 2 1 0.2000000E+01 0.9092662E+00 1  
INPUT DATA CARD 3 2 0.3000000E+01 -0.3646433E+00 1  
INPUT DATA CARD 4 1 0.4000000E+01 0.2594789E-01 1  
INPUT DATA CARD 5 2 0.5000000E+01 -0.1152945E+01 1  
INPUT DATA CARD 6 1 0.8000000E+01 0.9372235E+00 1  
INPUT DATA CARD 7 2 0.8000000E+01 0.2205468E+01 1  
INPUT DATA CARD 8 1 0.1100000E+02 -0.4912671E+00 1  
INPUT DATA CARD 9 2 0.1100000E+02 -0.2986642E+01 1  
INPUT DATA CARD 10 1 0.1500000E+02 0.3023730E+01 1  
INPUT DATA CARD 11 2 0.1500000E+02 0.2215436E+01 1

BLANK DATA CARD

INPUT DATA CARD 1 0 0.7000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00  
INPUT DATA CARD 2 0 0.7000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00  
INPUT DATA CARD 3 -1 0.2000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00  
INPUT DATA CARD 4 -1 0.1000000E+01 0.0000000E+00 0.0000000E+00 0.0000000E+00  
INPUT DATA CARD 5 -1 0.1000000E+01 0.0000000E+00 0.0000000E+00 0.0000000E+00

BLANK DATA CARD

	TBV	B=V	QB	XCTBV
1	0.1000000E+01	0.1093660E+01	1	1
2	0.2000000E+01	0.9092662E+00	1	1
3	0.3000000E+01	-0.3646433E+00	2	1
4	0.4000000E+01	0.2594789E-01	1	1
5	0.5000000E+01	-0.1152945E+01	2	1
6	0.8000000E+01	0.9372235E+00	1	1
7	0.8000000E+01	0.2205468E+01	2	1
8	0.1100000E+02	-0.4912671E+00	1	1
9	0.1100000E+02	-0.2986642E+01	2	1
10	0.1500000E+02	0.3023730E+01	1	1
11	0.1500000E+02	0.2215436E+01	2	1

Y()	IC	XCTIC	PTRB	UPPER	LOWER
1	0.7000000E+00	0	0.1200000E+01	0.0000000E+00	0.0000000E+00
2	0.7000000E+00	0	0.1200000E+01	0.0000000E+00	0.0000000E+00
3	0.2000000E+00	-1	0.0000000E+00	0.0000000E+00	0.0000000E+00
4	0.1000000E+01	-1	0.0000000E+00	0.0000000E+00	0.0000000E+00

5	0.1000000E+01	-1	0.0000000E+00	0.0000000E+00	0.0000000E+00
IBUT	4	LIN	010BVS	0	LITER 10
NBV	11	NEQ	2	NCN	3
				NWRITE	25
				SKIP	0
DELT	0.200000E-01	SPTRB	0.120000E+01	PNORM	0.000000E+00
				TSTART	0.000000E+00
				TSTOP	0.150000E+02

GENERATED

NRANKC 3

AUX

0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
0.0000000E+00	0.0000000E+00						

REPEATED TIMES ARE PARTICULAR SOLUTIONS

SAMPLE OUTPUT

	TIME	ITER 1	HF 10	SOLUTION
	0.0000000E+00	0.7000000E+00	0.7000000E+00	0.2000000E+00 0.1000000E+01 0.1000000E+01
	0.0000000E+00	0.8399999E+00	0.7000000E+00	0.2000000E+00 0.1000000E+01 0.1000000E+01
	0.0000000E+00	0.7000000E+00	0.8399999E+00	0.2000000E+00 0.1000000E+01 0.1000000E+01
	0.4999999E+00	0.9562657E+00	0.3497854E+00	
	0.4999999E+00	0.1079678E+01	0.2859135E+00	
	0.4999999E+00	0.1020139E+01	0.4604279E+00	
BV	0.1000000E+01	0.1075538E+01	0.1511326E+00	
BV	0.1000000E+01	0.1155195E+01	0.4435071E+01	
BV	0.1000000E+01	0.1182330E+01	0.2094327E+00	
	0.1499998E+01	0.1125338E+01	0.5862120E+01	
	0.1499998E+01	0.1146852E+01	-0.6211286E+01	
	0.1499998E+01	0.1246091E+01	0.5597012E+01	
BV	0.2000000E+01	0.1135816E+01	-0.2356429E+01	
BV	0.2000000E+01	0.1099705E+01	-0.1287959E+00	
BV	0.2000000E+01	0.1241062E+01	-0.8075535E+01	
	0.2499998E+01	0.1087675E+01	-0.1882297E+00	
	0.2499998E+01	0.1007850E+01	-0.2549233E+00	
	0.2499998E+01	0.1154379E+01	-0.2814492E+00	
BV	0.3000000E+01	0.9264440E+00	-0.4766998E+00	
BV	0.3000000E+01	0.8256610E+00	-0.4929921E+00	
BV	0.3000000E+01	0.9427206E+00	-0.5808073E+00	
	0.3499998E+01	0.5959560E+00	-0.8526036E+00	
	0.3499998E+01	0.4996783E+00	-0.8194996E+00	
	0.3499998E+01	0.5628073E+00	-0.9423068E+00	
BV	0.4000000E+01	0.7711613E+01	-0.1207367E+01	
BV	0.4000000E+01	0.7347226E+02	-0.1137285E+01	
BV	0.4000000E+01	-0.6967612E+02	-0.1263138E+01	
	0.4499998E+01	-0.5835585E+00	-0.1395411E+01	
	0.4499998E+01	-0.6130923E+00	-0.1308206E+01	
	0.4499998E+01	-0.6708438E+00	-0.1407490E+01	
BV	0.5000000E+01	-0.1268603E+01	-0.1287576E+01	
BV	0.5000000E+01	-0.1254860E+01	-0.1205191E+01	
BV	0.5000000E+01	-0.1351066E+01	-0.1257304E+01	
	0.5499998E+01	-0.1811308E+01	-0.8243835E+00	
	0.5499998E+01	-0.1761617E+01	-0.7655500E+00	
	0.5499998E+01	-0.1870204E+01	-0.7628422E+00	
	0.5999975E+01	-0.2040605E+01	-0.5088079E+01	
	0.5999975E+01	-0.1969967E+01	-0.2705427E+01	
	0.5999975E+01	-0.2064457E+01	0.2462750E+01	



	0.6499963E+01	-0.1835453E+01	0.8801509E+00
	0.6499963E+01	-0.1762322E+01	0.8667561E+00
	0.6499963E+01	-0.1822042E+01	0.9507104E+00
	0.6999950E+01	-0.1172173E+01	0.1740053E+01
	0.6999950E+01	-0.1113821E+01	0.1696112E+01
	0.6999950E+01	-0.1128167E+01	0.1789709E+01
	0.7499938E+01	-0.1483383E+00	0.2284041E+01
	0.7499938E+01	-0.1169468E+00	0.2222708E+01
	0.7499938E+01	-0.8689070E-01	0.2303221E+01
BV	0.8000000E+01	0.1027084E+01	0.2322242E+01
BV	0.8000000E+01	0.1026773E+01	0.2259459E+01
BV	0.8000000E+01	0.1090006E+01	0.2309370E+01
	0.8499988E+01	0.2076712E+01	0.1781559E+01
	0.8499988E+01	0.2047807E+01	0.1732094E+01
	0.8499988E+01	0.2126322E+01	0.1742690E+01
	0.8999975E+01	0.2724151E+01	0.7391631E+00
	0.8999975E+01	0.2676120E+01	0.7132661E+00
	0.8999975E+01	0.2750155E+01	0.6858172E+00
	0.9499963E+01	0.2768405E+01	-0.5844616E+00
	0.9499963E+01	0.2714257E+01	-0.5830164E+00
	0.9499963E+01	0.2767006E+01	-0.6384907E+00
	0.9999950E+01	0.2145331E+01	-0.1873320E+01
	0.9999950E+01	0.2098269E+01	-0.1847485E+01
	0.9999950E+01	0.2119461E+01	-0.1915392E+01
	0.1049994E+02	0.9568134E+00	-0.2793928E+01
	0.1049994E+02	0.9271247E+00	-0.2752050E+01
	0.1049994E+02	0.9148225E+00	-0.2815383E+01
BV	0.1100000E+02	-0.5428562E+00	-0.3083581E+01
BV	0.1100000E+02	-0.5499218E+00	-0.3036953E+01
BV	0.1100000E+02	-0.5896646E+00	-0.3081388E+01
	0.1149999E+02	-0.2001231E+01	-0.2625164E+01
	0.1149999E+02	-0.1986194E+01	-0.2585100E+01
	0.1149999E+02	-0.2041503E+01	-0.2602084E+01
	0.1199998E+02	-0.3053777E+01	-0.1487646E+01
	0.1199998E+02	-0.3022252E+01	-0.1462855E+01
	0.1199998E+02	-0.3078757E+01	-0.1451042E+01
	0.1249996E+02	-0.3416236E+01	0.8121765E+01
	0.1249996E+02	-0.3377142E+01	0.8642358E+01
	0.1249996E+02	-0.3421565E+01	0.1215385E+00
	0.1299995E+02	-0.2962417E+01	0.1709506E+01
	0.1299995E+02	-0.2925590E+01	0.1695791E+01
	0.1299995E+02	-0.2948729E+01	0.1743810E+01
	0.1349994E+02	-0.1764860E+01	0.2991118E+01
	0.1349994E+02	-0.1738658E+01	0.2963490E+01
	0.1349994E+02	-0.1737151E+01	0.3011996E+01
	0.1399993E+02	-0.8616453E-01	0.3588797E+01
	0.1399993E+02	-0.7567459E-01	0.3555022E+01
	0.1399993E+02	-0.5221295E-01	0.3592670E+01
	0.1449991E+02	0.1678929E+01	0.3323691E+01
	0.1449991E+02	0.1672778E+01	0.3292223E+01
	0.1449991E+02	0.1710635E+01	0.3311273E+01
BV	0.1500000E+02	0.3098001E+01	0.2227300E+01
BV	0.1500000E+02	0.3078233E+01	0.2205244E+01
BV	0.1500000E+02	0.3120300E+01	0.2203023E+01

# SAVE MATRIX

BOUNDARY VALUE, UNPTRBD SOLN, PTRBD SOLNS.....

1 0.100000E+01 0.100000E+01 0.100000E+01 0.100000E+01

2	0.221544E+01	0.222730E+01	0.220524E+01	0.220302E+01
3	0.302373E+01	0.309800E+01	0.307823E+01	0.312030E+01
4	-0.298664E+01	-0.308358E+01	-0.303695E+01	-0.308139E+01
5	-0.491267E+00	-0.542856E+00	-0.549922E+00	-0.589665E+00
6	0.220547E+01	0.232224E+01	0.225946E+01	0.230937E+01
7	0.937223E+00	0.102708E+01	0.102677E+01	0.109001E+01
8	-0.115294E+01	-0.128758E+01	-0.120519E+01	-0.125730E+01
9	0.259479E-01	0.771161E-01	0.734723E-02	0.696761E-02
10	-0.364643E+00	-0.476700E+00	-0.492992E+00	-0.580807E+00
11	0.909266E+00	0.113582E+01	0.109970E+01	0.124106E+01
12	0.109366E-01	0.107554E+01	0.115520E+01	0.118233E+01

1TH PIVOT	0.100000E+01	101
2TH PIVOT	-0.242767E-01	203
3TH PIVOT	-0.400273E-01	302

CONSTANTS 0.3166437E+00 0.2127744E+01 -0.1444387E+01

DET 0.0000000E+00 ANORM 0.3600357E+00

DIC VECTOR

0.2978843E+00 -0.2022144E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00

REPEATED TIMES ARE PARTICULAR SOLUTIONS

	TIME	SOLUTION
	0.0000000E+00	0.9978843E+00 0.4977856E+00 0.2000000E+00 0.1000000E+01 0.1000000E+01
	0.0000000E+00	0.1197461E+01 0.4977856E+00 0.2000000E+00 0.1000000E+01 0.1000000E+01
	0.0000000E+00	0.9978843E+00 0.5973426E+00 0.2000000E+00 0.1000000E+01 0.1000000E+01
	0.4999996E+00	0.1126580E+01 0.5407673E-01
	0.4999996E+00	0.1302536E+01 -0.3696122E-01
	0.4999996E+00	0.1172019E+01 0.1327531E+00
BV	0.1000000E+01	0.1090760E+01 -0.1602647E+00
BV	0.1000000E+01	0.1204340E+01 -0.3125080E+00
BV	0.1000000E+01	0.1166723E+01 -0.1188216E+00
	0.1499988E+01	0.9966838E+00 -0.1944188E+00
	0.1499988E+01	0.1027365E+01 -0.3665591E+00
	0.1499988E+01	0.1082568E+01 -0.1963261E+00
BV	0.2000000E+01	0.9069713E+00 -0.1648426E+00
BV	0.2000000E+01	0.8554781E+00 -0.3148813E+00
BV	0.2000000E+01	0.9818044E+00 -0.2055335E+00
	0.2499988E+01	0.8215081E+00 -0.1954806E+00
	0.2499988E+01	0.7076619E+00 -0.2905639E+00
	0.2499988E+01	0.8689127E+00 -0.2617813E+00
BV	0.3000000E+01	0.6885145E+00 -0.3609952E+00
BV	0.3000000E+01	0.5447734E+00 -0.3841960E+00
BV	0.3000000E+01	0.7000539E+00 -0.4350211E+00
	0.3499988E+01	0.4389986E+00 -0.6526104E+00
	0.3499988E+01	0.3016998E+00 -0.6053670E+00
	0.3499988E+01	0.4153984E+00 -0.7163787E+00
BV	0.4000000E+01	0.2999910E-01 -0.9777138E+00
BV	0.4000000E+01	-0.6947887E-01 -0.8777356E+00
BV	0.4000000E+01	-0.1989930E-01 -0.1017341E+01
	0.4499988E+01	-0.5203185E+00 -0.1192422E+01
	0.4499988E+01	-0.5624028E+00 -0.1068035E+01
	0.4499988E+01	-0.5823882E+00 -0.1200983E+01
BV	0.5000000E+01	-0.1120245E+01 -0.1156006E+01
BV	0.5000000E+01	-0.1100595E+01 -0.1038511E+01
BV	0.5000000E+01	-0.1178872E+01 -0.1134463E+01

ORIGINAL PAGE IS  
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	0.5499988E+01	-0.1620492E+01	-0.7880933E+00
	0.5499988E+01	-0.1549582E+01	-0.7042078E+00
	0.5499988E+01	-0.1662362E+01	-0.7443231E+00
	0.5999975E+01	-0.1855837E+01	-0.1092579E+00
	0.5999975E+01	-0.1755064E+01	-0.7531327E-01
	0.5999975E+01	-0.1872784E+01	-0.5556232E-01
	0.6499963E+01	-0.1699203E+01	0.7497174E+00
	0.6499963E+01	-0.1594890E+01	0.7305697E+00
	0.6499963E+01	-0.1689656E+01	0.7998874E+00
	0.6999950E+01	-0.1111567E+01	0.1574812E+01
	0.6999950E+01	-0.1028356E+01	0.1512099E+01
	0.6999950E+01	-0.1080273E+01	0.1610119E+01
	0.7499938E+01	-0.1702995E+00	0.2125805E+01
	0.7499938E+01	-0.1255597E+00	0.2038289E+01
	0.7499938E+01	-0.1266064E+00	0.2139440E+01
BV	0.8000000E+01	0.9355232E+00	0.2207214E+01
BV	0.8000000E+01	0.9350324E+00	0.2117652E+01
BV	0.8000000E+01	0.9802646E+00	0.2198066E+01
	0.8499988E+01	0.1943516E+01	0.1732428E+01
	0.8499988E+01	0.1902238E+01	0.1661880E+01
	0.8499988E+01	0.1978796E+01	0.1704794E+01
	0.8999975E+01	0.2584316E+01	0.7611016E+00
	0.8999975E+01	0.2515758E+01	0.7241887E+00
	0.8999975E+01	0.2602825E+01	0.7231754E+00
	0.9499963E+01	0.2655141E+01	-0.5033256E+00
	0.9499963E+01	0.2577876E+01	-0.5012218E+00
	0.9499963E+01	0.2654168E+01	-0.5417461E+00
	0.9999950E+01	0.2082500E+01	-0.1757527E+01
	0.9999950E+01	0.2015361E+01	-0.1720620E+01
	0.9999950E+01	0.2064128E+01	-0.1787455E+01
	0.1049994E+02	0.9542516E+00	-0.2673746E+01
	0.1049994E+02	0.9119142E+00	-0.2613962E+01
	0.1049994E+02	0.9244131E+00	-0.2689033E+01
BV	0.1100000E+02	-0.4902771E+00	-0.2987442E+01
BV	0.1100000E+02	-0.5003212E+00	-0.2920888E+01
BV	0.1100000E+02	-0.5235572E+00	-0.2980915E+01
	0.1149999E+02	-0.1911017E+01	-0.2573172E+01
	0.1149999E+02	-0.1889516E+01	-0.2510005E+01
	0.1149999E+02	-0.1939668E+01	-0.2556796E+01
	0.1199998E+02	-0.2950526E+01	-0.1487717E+01
	0.1199998E+02	-0.2905504E+01	-0.1452355E+01
	0.1199998E+02	-0.2968323E+01	-0.1461712E+01
	0.1249996E+02	-0.3325244E+01	0.3405523E+01
	0.1249996E+02	-0.3269433E+01	0.4145670E+01
	0.1249996E+02	-0.3329082E+01	0.6272334E+01
	0.1299995E+02	-0.2903719E+01	0.1630720E+01
	0.1299995E+02	-0.2851151E+01	0.1611114E+01
	0.1299995E+02	-0.2894033E+01	0.1655135E+01
	0.1349994E+02	-0.1749057E+01	0.2902075E+01
	0.1349994E+02	-0.1711665E+01	0.2862608E+01
	0.1349994E+02	-0.1729390E+01	0.2916963E+01
	0.1399993E+02	-0.1128560E+00	0.3511220E+01
	0.1399993E+02	-0.9790677E-01	0.3462981E+01
	0.1399993E+02	-0.8873010E-01	0.3514023E+01
	0.1449991E+02	0.1620008E+01	0.3274558E+01
	0.1449991E+02	0.1611187E+01	0.3229625E+01
	0.1449991E+02	0.1642563E+01	0.3265780E+01
BV	0.1500000E+02	0.3023641E+01	0.2215360E+01
BV	0.1500000E+02	0.2995376E+01	0.2183884E+01

BV 0.1500000E+02 0.3039534E+01 0.2198140E+01

SAVE MATRIX

BOUNDARY VALUE UNPTRBD SOLN, PTRBD SOLNS.....

1	0.1000000E+01	0.1000000E+01	0.1000000E+01	0.1000000E+01
2	0.221544E+01	0.221536E+01	0.218388E+01	0.219814E+01
3	0.302373E+01	0.302364E+01	0.299538E+01	0.303953E+01
4	-0.298664E+01	-0.298744E+01	-0.292089E+01	-0.298592E+01
5	-0.491267E+00	-0.490277E+00	-0.500321E+00	-0.523557E+00
6	0.220547E+01	0.220721E+01	0.211765E+01	0.219807E+01
7	0.937223E+00	0.935523E+00	0.935032E+00	0.980265E+00
8	-0.115294E+01	-0.115601E+01	-0.103851E+01	-0.113446E+01
9	0.259479E-01	0.299991E-01	-0.694789E-01	-0.198993E-01
10	-0.364643E+00	-0.360995E+00	-0.384196E+00	-0.435021E+00
11	0.909266E+00	0.906971E+00	0.855478E+00	0.981804E+00
12	0.109366E-01	0.109076E+01	0.120434E+01	0.116672E+01
	1TH PIVOT	0.100000E+01	101	
	2TH PIVOT	-0.314760E-01	202	
	3TH PIVOT	0.313559E-01	303	

CONSTANTS 0.1002117E+01 -0.2792611E-02 0.6740219E-03

DBT -0.8884858E+00

ANORM 0.5619149E-03

DIC VECTOR

-0.5578995E-03 0.6705523E-04 0.0000000E+00 0.0000000E+00 0.0000000E+00

REPEATED TIMES ARE PARTICULAR SOLUTIONS

	TIME	ITER 3 OF 10	SOLUTION			
	0.0000000E+00	0.9973264E+00	0.4978526E+00	0.2000000E+00	0.1000000E+01	0.1000000E+01
	0.0000000E+00	0.1196792E+01	0.4978526E+00	0.2000000E+00	0.1000000E+01	0.1000000E+01
	0.0000000E+00	0.9973264E+00	0.5974230E+00	0.2000000E+00	0.1000000E+01	0.1000000E+01
	0.4999996E+00	0.1126123E+01	0.5438244E-01			
	0.4999996E+00	0.1301975E+01	-0.3662245E-01			
	0.4999996E+00	0.1171563E+01	0.1330713E+00			
BV	0.1000000E+01	0.1090500E+01	-0.1598161E+00			
BV	0.1000000E+01	0.1204012E+01	-0.3119694E+00			
BV	0.1000000E+01	0.1166467E+01	-0.1183618E+00			
	0.1499988E+01	0.9966580E+00	-0.1939446E+00			
	0.1499988E+01	0.1027320E+01	-0.3659835E+00			
	0.1499988E+01	0.1082553E+01	-0.1958463E+00			
BV	0.2000000E+01	0.9071650E+00	-0.1644560E+00			
BV	0.2000000E+01	0.8557010E+00	-0.3144059E+00			
BV	0.2000000E+01	0.9820085E+00	-0.2051469E+00			
	0.2499988E+01	0.8218551E+00	-0.1952637E+00			
	0.2499988E+01	0.7080753E+00	-0.2902899E+00			
	0.2499988E+01	0.8692692E+00	-0.2615687E+00			
BV	0.3000000E+01	0.6889194E+00	-0.3609821E+00			
BV	0.3000000E+01	0.5452628E+00	-0.3841680E+00			
BV	0.3000000E+01	0.7004653E+00	-0.4350157E+00			
	0.3499988E+01	0.4393614E+00	-0.6527848E+00			
	0.3499988E+01	0.3021439E+00	-0.6055679E+00			
	0.3499988E+01	0.4157635E+00	-0.7165620E+00			
BV	0.4000000E+01	0.3023940E-01	-0.9780172E+00			
BV	0.4000000E+01	-0.6917900E-01	-0.8780972E+00			
BV	0.4000000E+01	-0.1966124E-01	-0.1017653E+01			

	0.4499988E+01	-0.5202453E+00	-0.1192773E+01
	0.4499988E+01	-0.5623034E+00	-0.1068457E+01
	0.4499988E+01	-0.5823204E+00	-0.1201337E+01
BV	0.5000000E+01	-0.1120339E+01	-0.1156316E+01
BV	0.5000000E+01	-0.1100701E+01	-0.1038892E+01
BV	0.5000000E+01	-0.1178973E+01	-0.1134771E+01
	0.5499988E+01	-0.1620719E+01	-0.7882960E+00
	0.5499988E+01	-0.1549849E+01	-0.7044602E+00
	0.5499988E+01	-0.1662591E+01	-0.7445205E+00
	0.5999975E+01	-0.1856129E+01	-0.1093147E+00
	0.5999975E+01	-0.1755411E+01	-0.7539177E+01
	0.5999975E+01	-0.1873079E+01	-0.5561318E+01
	0.6499963E+01	-0.1699487E+01	0.7498049E+00
	0.6499963E+01	-0.1595233E+01	0.7306663E+00
	0.6499963E+01	-0.1689939E+01	0.7999821E+00
	0.6999950E+01	-0.1111778E+01	0.1575008E+01
	0.6999950E+01	-0.1028616E+01	0.1512332E+01
	0.6999950E+01	-0.1080476E+01	0.1610318E+01
	0.7499938E+01	-0.1703979E+00	0.2126056E+01
	0.7499938E+01	-0.1256821E+00	0.2038593E+01
	0.7499938E+01	-0.1266947E+00	0.2139690E+01
BV	0.8000000E+01	0.9355519E+00	0.2207460E+01
BV	0.8000000E+01	0.9350631E+00	0.2117948E+01
BV	0.8000000E+01	0.9803001E+00	0.2198301E+01
	0.8499988E+01	0.1943652E+01	0.1732606E+01
	0.8499988E+01	0.1902399E+01	0.1662101E+01
	0.8499988E+01	0.1978937E+01	0.1704964E+01
	0.8999975E+01	0.2584519E+01	0.7611817E+00
	0.8999975E+01	0.2515999E+01	0.7242907E+00
	0.8999975E+01	0.2603026E+01	0.7232467E+00
	0.9499963E+01	0.2655359E+01	-0.5033556E+00
	0.9499963E+01	0.2578136E+01	-0.5012513E+00
	0.9499963E+01	0.2654379E+01	-0.5417817E+00
	0.9999950E+01	0.2082677E+01	-0.1757649E+01
	0.9999950E+01	0.2015577E+01	-0.1720763E+01
	0.9999950E+01	0.2064255E+01	-0.1787580E+01
	0.1049994E+02	0.9543520E+00	-0.2673926E+01
	0.1049994E+02	0.9120432E+00	-0.2614173E+01
	0.1049994E+02	0.9245045E+00	-0.2689205E+01
BV	0.1100000E+02	-0.4902712E+00	-0.2987630E+01
BV	0.1100000E+02	-0.5003040E+00	-0.2921115E+01
BV	0.1100000E+02	-0.5235552E+00	-0.2986093E+01
	0.1149999E+02	-0.1911096E+01	-0.2573324E+01
	0.1149999E+02	-0.1889607E+01	-0.2515190E+01
	0.1149999E+02	-0.1939749E+01	-0.2556934E+01
	0.1199998E+02	-0.2950666E+01	-0.1487803E+01
	0.1199998E+02	-0.2905669E+01	-0.1452456E+01
	0.1199998E+02	-0.2968460E+01	-0.1461786E+01
	0.1249996E+02	-0.3325411E+01	0.3404944E+01
	0.1249996E+02	-0.3269627E+01	0.4145324E+01
	0.1249996E+02	-0.3329236E+01	0.6272632E+01
	0.1299995E+02	-0.2903874E+01	0.1630794E+01
	0.1299995E+02	-0.2851327E+01	0.1611201E+01
	0.1299995E+02	-0.2894167E+01	0.1655208E+01
	0.1349994E+02	-0.1749166E+01	0.2902203E+01
	0.1349994E+02	-0.1711786E+01	0.2862759E+01
	0.1349994E+02	-0.1729476E+01	0.2917081E+01
	0.1399993E+02	-0.1128939E+00	0.3511371E+01
	0.1399993E+02	-0.9793961E+01	0.3463157E+01

ORIGINAL PAGE IS  
OF POOR QUALITY

	0.1399993E+02	-0.8875316E-01	0.3514157E+01
	0.1449991E+02	0.1620042E+01	0.3274693E+01
	0.1449991E+02	0.1611238E+01	0.3229779E+01
	0.1449991E+02	0.1642606E+01	0.3265895E+01
BV	0.1500000E+02	0.3023735E+01	0.2215452E+01
BV	0.1500000E+02	0.2995492E+01	0.2183982E+01
BV	0.1500000E+02	0.3039624E+01	0.2198212E+01

# SAVE MATRIX

BOUNDARY VALUE UNPTRBD SOLN, PTRBD SOLNS.....

1	0.1000000E+01	0.1000000E+01	0.1000000E+01	0.1000000E+01
2	0.221544E+01	0.221545E+01	0.218398E+01	0.219821E+01
3	0.302373E+01	0.302374E+01	0.299549E+01	0.303962E+01
4	-0.298664E+01	-0.298763E+01	-0.292111E+01	-0.298609E+01
5	-0.491267E+00	-0.490271E+00	-0.500304E+00	-0.523555E+00
6	0.220547E+01	0.220746E+01	0.211795E+01	0.219830E+01
7	0.937223E+00	0.935552E+00	0.935063E+00	0.980300E+00
8	-0.115294E+01	-0.115632E+01	-0.103889E+01	-0.113477E+01
9	0.259479E-01	0.302394E-01	-0.691790E-01	-0.196612E-01
10	-0.364643E+00	-0.360982E+00	-0.384168E+00	-0.435016E+00
11	0.909266E+00	0.907165E+00	0.855701E+00	0.982008E+00
12	0.109366E-01	0.109050E+01	0.120401E+01	0.116647E+01

1TH PIVOT 0.100000E+01 101

2TH PIVOT -0.314703E-01 202

3TH PIVOT 0.313617E-01 303

CONSTANTS 0.9993438E+00 0.3443009E-03 0.3118941E-03

DBT -0.8552962E+00 ANORM 0.7530599E-04

# DIC VECTOR

0.6860495E-04 0.3105402E-04 0.0000000E+00 0.0000000E+00 0.0000000E+00

REPEATED TIMES ARE PARTICULAR SOLUTIONS

ITER 4 OF 4						
TIME		SOLUTION				
	0.0000000E+00	0.9973950E+00	0.4978837E+00	0.2000000E+00	0.1000000E+01	0.1000000E+01
	0.4999996E+00	0.1126198E+01	0.5437643E-01			
BV	0.1000000E+01	0.1090565E+01	-0.1598548E+00			
	0.1499988E+01	0.9966997E+00	-0.1940058E+00			
BV	0.2000000E+01	0.9071740E+00	-0.1645237E+00			
	0.2499988E+01	0.8218322E+00	-0.1953211E+00			
BV	0.3000000E+01	0.6888731E+00	-0.3610167E+00			
	0.3499988E+01	0.4393052E+00	-0.6527909E+00			
BY	0.4000000E+01	0.3018703E-01	-0.9779964E+00			
	0.4499988E+01	-0.5202802E+00	-0.1192725E+01			
BV	0.5000000E+01	-0.1120350E+01	-0.1156263E+01			
	0.5499988E+01	-0.1620708E+01	-0.7882488E+00			
	0.5999975E+01	-0.1856094E+01	-0.1092827E+00			
	0.6499963E+01	-0.1699442E+01	0.7498147E+00			
	0.6999950E+01	-0.1111734E+01	0.1574995E+01			
	0.7499938E+01	-0.1703653E+00	0.2126025E+01			
BV	0.8000000E+01	0.9355652E+00	0.2207417E+01			
	0.8499988E+01	0.1943647E+01	0.1732563E+01			
	0.8999975E+01	0.2584495E+01	0.7611488E+00			
	0.9499963E+01	0.2655319E+01	-0.5033699E+00			
	0.9999950E+01	0.2082635E+01	-0.1757638E+01			
	0.1049994E+02	0.9543239E+00	-0.2673894E+01			
BV	0.1100000E+02	-0.4902816E+00	-0.2987592E+01			
	0.1149999E+02	-0.1911094E+01	-0.2573289E+01			
	0.1199998E+02	-0.2950648E+01	-0.1487777E+01			
	0.1249996E+02	-0.3325378E+01	0.3406220E-01			
	0.1299995E+02	-0.2903840E+01	0.1630788E+01			
	0.1349994E+02	-0.1749135E+01	0.2902186E+01			
	0.1399993E+02	-0.1128750E+00	0.3511342E+01			
	0.1449991E+02	0.1620046E+01	0.3274663E+01			
BV	0.1500000E+02	0.3023725E+01	0.2215425E+01			